Platform for Agricultural Risk Management

Assessing value chain risks to design agricultural risk management strategies

A practitioner's toolkit

TOOLKIT

CAPACITY DEVELOPMENT


PARM
PLATFORM FOR
AGRICULTURAL RISK
MANAGEMENT

Platform
for Agricultural
Risk Management

Managing risks to improve farmers' livelihoods

Assessing value chain risks to design agricultural risk management strategies

A practitioner's toolkit

PARM (2021)

Assessing value chain risks to design agricultural risk managment strategies: A practitioner's toolkit
by Alliance of Bioversity International and CIAT

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About PARM

The Platform for Agricultural Risk Management (PARM) is a global initiative focused on making risk management an integral part of policy planning and implementation in the agricultural sector in developing countries. This facility is a mandate of the G8 and G20 discussions on food security and agricultural growth, supported by a multi-stakeholder partnership between the European Commission (EC), the French Development Agency (AFD), the Italian Development Cooperation (DGCS) the International Fund for Agricultural Development (IFAD), the German Cooperation (BMZ/KfW). In Africa the platform has developed a strategic partnership with the New Partnership for Africa's Development (NEPAD) and operates within the Comprehensive Africa Agriculture Development Programme (CAADP) framework.

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Acronyms

AR	Accessibility or Applicability Rating
ARM	Agricultural Risk Management
AT	Assessment Team
AVC	Agricultural Value Chain
AVC-RAS	Agricultural Value Chain Risk Assessment Study
CDD	Maximum number of Consecutive Dry Days
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station
CHIRTS	Climate Hazards Group InfraRed Temperature with Station
CIAT	International Center for Tropical Agriculture
CMR	Capacity to Manage Risks
CPI	Consumer Price Index
CRVA	Climate Risk Vulnerability Assessment
CV	Coefficient of Variation
EM-DAT	Emergency Events Database
ER	Effectiveness Rating
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
FOB	Free-On-Board
G20	Group of Twenty
GDP	Gross Domestic Product
GIS	Geoinformation System
HDZ	Hazards combination layer
HI	Thermal Index
ICRW	International Centre for Research on Women
IFAD	International Fund for Agricultural Development
ILO	International Labor Organization
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
KII	Key Informant Interview

LGP	Length of Growing Period
M4P	Making Markets Work Better for the Poor
MOA	Ministry of Agriculture
NDD	Number of dry days during the growing season
NDWS	Number of days with a ratio of actual to potential evapotranspiration below 0.5
NGO	Non-Governmental Organization
NT35	Total number of days with maximum temperature greater or equal to 35°C
NT-X	Number of days with temperatures above a threshold of X ºC.
NWLD	Number of days during the growing season with waterlogging in the soil
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PARM	Platform for Agricultural Risk Management
PCA	Principal Component Analysis
P5D	Maximum 5-day running average precipitation
P95	The 95th percentile of daily precipitation
PPI	Producer Price Index
SD	Standard Deviation
SLGP	Start of the growing season
TAI	Thornthwaite's Aridity Index
THI	Temperature Humidity Index
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNISDR	United Nations International Strategy for Disaster Risk Reduction
USAID	United States Agency for International Development
VI	Vulnerability Index
WTO	World Trade Organization

Introduction: what is in this toolkit?

This toolkit provides step-by-step guidance to perform an Agricultural Value Chain Risk Assessment Study (AVC-RAS) at the country level. The goal of an AVC-RAS is to rigorously assess and prioritize the major risks affecting actors along agricultural value chains and to identify the actionable components of an integrated risk management strategy for the value chain, using a gender lens throughout. This toolkit provides examples and tools for conducting a general AVC-RAS with a focus on managing risks in agricultural production systems and improving value chain resilience at national scales. Assessing and prioritizing risks is a main component of a good risk management strategy and can generate awareness and a shared view of risks. There are many components in combining an identified value chain approach with a holistic agricultural risk assessment. Considering multiple actors and risks, their complex relationships, and the potential effects of diverse events on individual actors and larger systems is important. Integrating different sources and types of data for more informed and robust decision-making process is also needed. This toolkit provides a structure and tools to deal with these inherent intricacies in an AVC-RAS, recognizing that assessment teams need a high level of flexibility and practicality to deal with the specific conditions in each AVC-RAS.

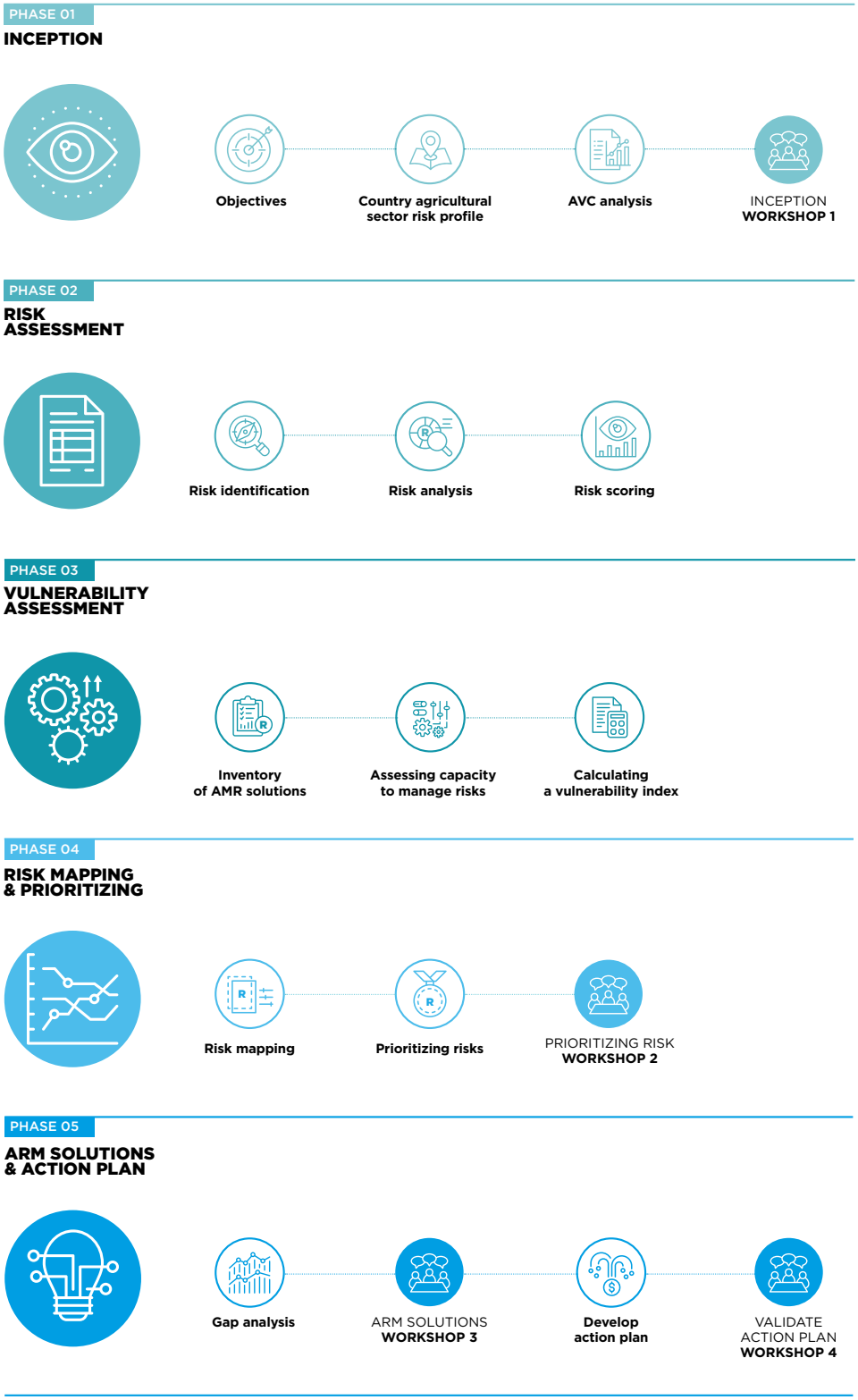
Goals of agricultural risk assessment studies are helping decision makers understand the risk profile of value chain participants and suggesting tailored agricultural risk management (ARM) strategies for selected AVCs (Jaffee et al., 2008). Specifically, AVC-RAS aim to:

- offer information about a value chain's main risk factors and how likely they are;
- analyze their economic, agricultural, and livelihood impacts;
- identify and assess existing ARM capacity, including tools and policy instruments;
- provide guidance for prioritizing agricultural risks;
- discerning the main ARM gaps and needs;
- creating and implementing an ARM strategy with stakeholder support.

Target audiences of the toolkit are development practitioners, staff of ministries, policy makers, development agencies, government agents, NGOs, private-sector actors, researchers (especially from research for development fields), financial institutions and other stakeholders interested in performing holistic agricultural risk assessments and developing feasible action plans with a focus on one or more AVCs. These different clients can have different priorities. This toolkit also therefore highlights elements of interest to specific groups, especially those relevant to food security, gender, and the livelihoods of vulnerable groups.

The toolkit is structured according to the risk management process (ISO, 2009a). The steps required to conduct an AVC-RAS are illustrated in Figure 1.1. The methodology presents a rapid approach to be executed within a time frame of 12 weeks, with different components running simultaneously. The main concepts for each of these steps are summarized in this main document, which is intended as a reference for all stakeholders on the overall process. The specifics of "how to" is provided in the Annexes.

Figure I.1. Sections in this toolkit based on the sequential steps of an AVC-RAS.



Key risks to agriculture and agricultural value chains

Every process and activity in each agricultural value chain is exposed to uncertain factors and therefore involves risk. The key elements of a risk assessment are estimating the probability and impact of a risk event. Risks can affect various actors along the agricultural value chain (AVC) to different extents. Idiosyncratic risks are risk events that typically affects only individual farms or firms; examples include illness or the death of laborers or animals, equipment breakdown, and plant pests and diseases that afflict only one farm at a time (Jaffee et al., 2010). Covariate or systemic risks involve many enterprises simultaneously and therefore can have a significant effect on the entire AVC, such as a drought, a price drop, pest and diseases or sudden regulatory changes. This toolkit focuses on these systemic risks, with the AVC-RAS taking a holistic perspective on the risks threatening a country's most relevant AVCs.

Relevant risks include:

- **Production risks**: Heavy rainfall, rainfall variability, floods, droughts, hail, hurricanes, crop pests, livestock diseases, contamination, earthquakes, volcanoes, wildfires
- **Price and financial risks**: Input and output price volatility, input prices and availability, input quality, market stability (fluctuations of demand/supply), changes in production standards, interest rate volatility, exchange rate volatility
- **Logistical risks**: Physical disruption of infrastructure and facilities, disruption of the energy supply, disruption of communication networks
- **Policy and institutional risks**: Political instability, regulatory changes, trade restrictions

Risk assessment studies[1], performed by PARM, provide examples of estimations of probability and impact of various risks affecting agriculture in the countries Cape Verde, Liberia, Ethiopia, Cameroon, Niger, Senegal, and Uganda.

Risks are different from constraints, even though they are often mixed-up during risk analysis. Risk events are considered as events that are deviations from the expected future. They can also be called shocks. Risk events have a certain chance of occurring, so one cannot know whether, when and with what magnitude they will occur. Therefore, risk analysis involves making estimations about these factors, based on underlying assumptions. Constraints are adverse events that can be anticipated or expected to occur regularly such as continuous soil erosion, social discrimination etc. This analysis is focuses on analyzing risks. Yet constraints need to be considered when discussing actors' capacity to manage risks and the effectiveness of risk management solutions in a specific context.

Definitions of key terms used in this toolkit are in Box I.1.

1 https://www.p4arm.org/document-type/risk-assessment/

Box I.1. Key Terms used in an AVC-RAS.

Agricultural Risk: A country's agricultural production faces numerous internal and external factors and influences that create uncertainty on whether and when stakeholders will achieve their objectives. The consequence of this uncertainty for a stakeholder's objectives can be understood as "risk" (ISO, 2009a). Each process and activity in each agricultural value chain is exposed to uncertain factors and therefore involves risk. Risk can be measured by two variables, the probability that the event or hazard will occur, and its impact in the form of loss. Probability refers to the likelihood of a risk event occurring; it can be measured qualitatively, e.g., unlikely versus highly likely, or quantitatively, e.g., a 30% probability. Impact can also be called severity, magnitude, or consequence (PARM, 2018a). Risks can affect various actors along the AVC to different extents, and have a certain probability of occurring, so we cannot know whether and when they will occur.

Agricultural Risk Management (ARM): a stakeholder needs to face and address risks to increase the chance of achieving their objectives. This is called "risk management" and it comprises the following main steps: identification, analysis, control or treatment, and monitoring of risks (ISO, 2009b).

Client: the stakeholder that will use the action plan as the end product of the AVC-RA, such as an agricultural ministry, or a bank or donor who provides financing to improve a country's ARM.

Hazard: a physical, biological, or socioeconomic source that may cause harm to the AVC and its actors (ISO, 2009a). It can also be the source or the cause of risk. Hazards include events linked to natural processes such as climate, biology, or tectonics, and other processes and sources such as the AVC's markets, financial markets, policy, politics, infrastructure, and operations.

Risk Mitigation: is implementing measures that reduce the probability or impact of a risk event.

Value Chain: a series of connected organizations, resources, and information sources involved in creating and delivering value to a final consumer (Lundy et al., 2014), with both direct and indirect actors:
Direct actors (also called micro-level actors (Springer-Heinze, 2018)) are involved in productive processes, post-harvest handling, processing, and commercialization. They own the product in one or more links in the chain and are exposed to direct risks linked to the product (Gottret et al., 2011).
Indirect actors include suppliers, operational service providers, support service providers, and regulatory bodies (Gottret et al., 2011). While they may be involved with the product at some link in the chain, they do not assume possession of it at any time, so they only face indirect risks. Indirect actors providing operational and support services to direct actors are also called meso level actors, whereas regulatory bodies are also referred to as macro level actors (Springer-Heinze, 2018).

Vulnerability: can be defined as a function of exposure, sensitivity, and capacity to adapt to change and manage risks in the face of future losses (IPCC, 2007). It is the ability of farmers, producers, and other AVC actors to manage risks and potential losses when unfavorable events happen in a given time frame. The vulnerability of individual actors in a value chain, and of the whole value chain, depends on the nature of the risks as defined by probability and impact, coupled with how effective existing risk management strategies are. Combine exposure to different types of risk and sensitivity or response to change, allows potential impact at a community level to be quantified without considering adaptation measures (Locatelli et al., 2008). The most vulnerable actors lack the capacity to mitigate potential risk impacts by identifying options to manage potential losses, and who do not properly plan or implement decisions that reduce risks.

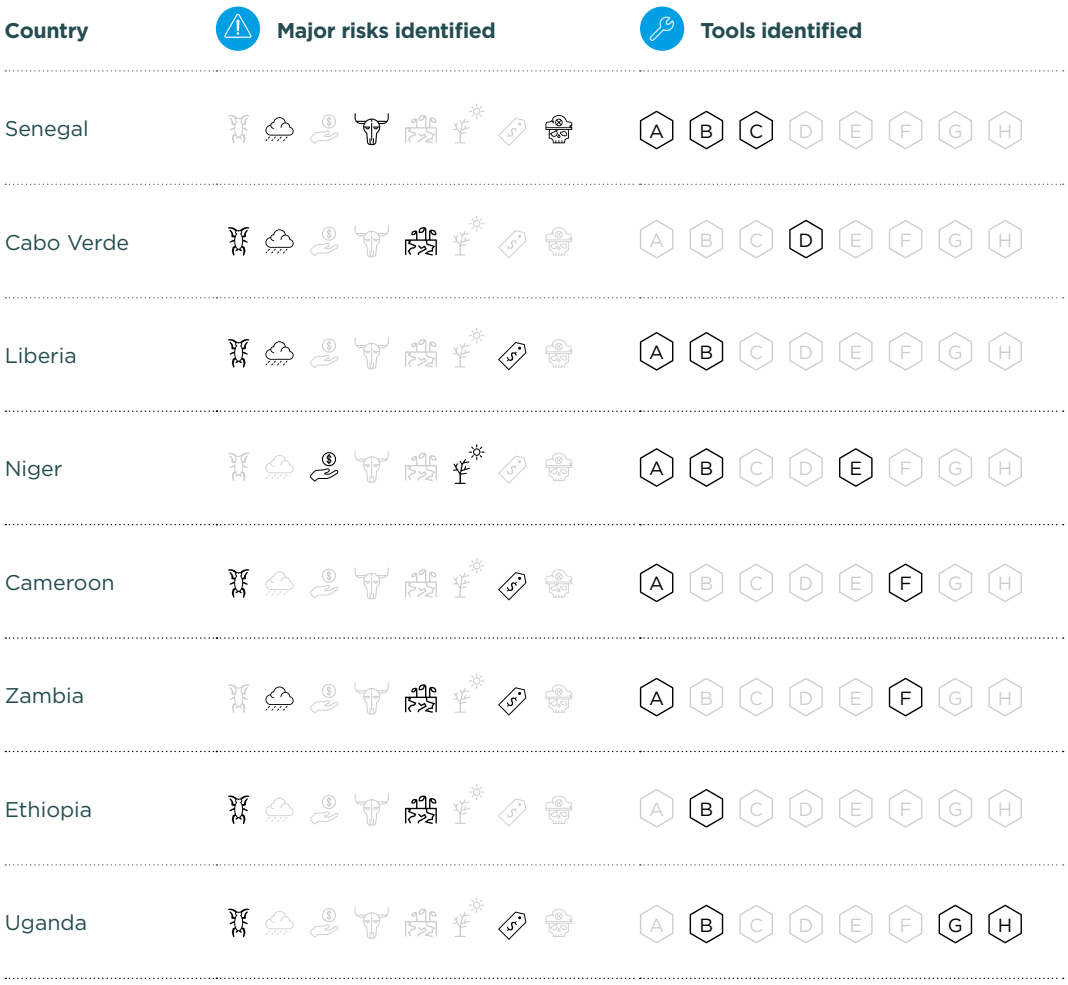
Platform for Agricultural Risk Management (PARM) experience for this Toolkit

The Platform for Agricultural Risk Management (PARM) is a global partnership on Agricultural Risk Management (ARM) for development. PARM was established in 2013 as an outcome of the Group of Twenty (G20) discussions on agricultural growth and food security, it provides technical support to developing country governments for integrating ARM into policies, institutional capacities, and investments to move away from a culture of coping with disasters towards smart management of risk. From 2013 to 2019 (Horizon 1), PARM finalized Agricultural Risk Assessment studies in the following countries (PARM, 2019a): Cape Verde, Liberia, Ethiopia, Cameroon, Niger, Senegal, and Uganda.[2] The Risk Assessment Studies have shown that climate related risks, pest and diseases as well as financial shocks are major risks in most of the countries. Figure 1.2 is showing at a glance which risks, and which ARM tools have been identified in each of the countries. This toolkit is based on much of the knowledge generated on agricultural risks and management.

PARM will continue its mandate in new countries in its second phase from 2019 to 2024 (Horizon 2). Although PARM currently focuses on Africa, it may expand to other continents. PARM will strengthen its focus on developing ARM programs for investments by involving various actors, such as public and private entities and non-governmental organizations (NGOs). Risk assessment studies are integral to establishing adequate ARM investment plans.

2 PARM FINAL PROGRAMME REPORT on the key achievements from 2014-2019: https://p4arm.org/document/parm-final-report-2014-2019/

Figure I.2. Major risks and tools identified by country.



Source: PARM, 2019a

Planning the Agricultural Value Chain Risk Assessment Study (AVC-RAS)

The different stages of an AVC-RAS are made up of four components. The first is selecting the **assessment team (AT)** team that will be in charge of conducting the AVC-RAS, and a **steering committee** to guide them. The second is to begin thinking about the stakeholder workshops that will be used to guide many elements of the whole analysis. The third component is undertaking **a literature review and data analysis** that can provide basic information and inputs that sets the framing context for the AVC-RAS. The final component is **interviews with AVC experts and actor groups** who are involved with or knowledgeable about agricultural value chains and the risks they face.

This plan includes an overview of suggested steps and activities to conduct the study within an AVC-RAS 12-week time frame, but depending on budget and scope, a longer time frame may be recommended. This work plan assumes that a simple set of objectives and a small number of AVCs were defined before the study starts and guide the analysis. It also assumes that many components will happen concurrently.

AVC-RAS Staffing

The **assessment team (AT)** is the team in charge of conducting the AVC-RAS. Below we suggest a generic structure and roles for the AT necessary to conduct a full analysis for one or two value chains in a specific region. Yet the number of team members and roles should be adjusted according to the regions, value chains and specific requirements of the study. A Team leader is responsible for leading the entire assessment team, and they should have both strong experience in agricultural risk assessment and managing projects and people. The core assessment team (3-5 people) plans and executes project activities, such as collecting and analyzing data, engaging with local actors, facilitating participatory processes, and writing the report. The core team should have general knowledge and experience working with the agricultural sector, and team members should collectively have: a) a strong ability to communicate with private- and public-sector actors; b) the ability to conduct interviews and facilitate participatory processes; c) experience with data collection and analysis, with experience in time series analysis and Geoinformation Systems (GIS); d) experience with AVC analysis and, if possible, with agricultural risk assessment and management; and e) knowledge of gender dynamics in agriculture, including value chains.

Optional support teams can be useful if there is a need and the budget. These support teams can include technical advisors with specific technical knowledge and advice on the AVC and/or the local environment, cultural and gender considerations. The skills should be complimentary to the team's skills. Local support teams can help facilitate contacts with local stakeholders and organize logistics. For this, the social network and communication skills of candidates are key.

A steering panel can represent stakeholder interests and provide higher-level input, and ideally be key to AVC-RAS implementation and its action plan. The steering panel can include the clients of the AVC-RAS action plan, the funders of the study, and representatives of key direct users and implementers of the action plan. The steering panel is involved

in making some key decisions during the study, like defining the risk scoring framework, prioritizing the main risks, or prioritizing measures to address the risks. Note that members of the steering panel may also be asked to participate in one or more of the four stakeholder workshops, so it is critical that anyone selected is knowledgeable, motivated, reliable, and responsive with time to dedicate to this work.

Stakeholder Workshops

Four stakeholder workshops are key to the AVC-RAS. This approach uses stakeholders to make important decisions, such as defining the objectives and scope of the study, deciding on the short list of relevant risks and AVC actor groups, and picking appropriate risk management solutions for the action plan. While the stakeholder workshops are not really the second thing that happens, they are fundamentally important to the other early efforts. As noted above, steering committee members may attend the stakeholder workshops, or they may recommend other people. Compiling lists of people recommended to participate in the stakeholder workshops is also a way of identifying AVC experts and other actors to interview and knowledgeable people who may provide information for the background literature and data analysis, described below.

The process of completing the AVC-RAS involves a series of up to four **stakeholder workshops**, with different compositions, formats, agendas, and purposes, to facilitate key decisions. They take place at crucial moments along the introduced three main steps of: 1) defining objectives and scope of the study, 2) deciding on the key risks and vulnerabilities, and 3) choosing the solutions to be included into a final action plan. The first is the inception workshop to kick off the AVC-RAS study process and select risk assessment parameters such as criteria for impact and probability scores. The second workshop is geared toward risk prioritization. Workshop 3 will yield a shortlist of prioritized ARM solutions and advance the team toward drafting an action plan, and workshop 4 serves as a capstone to validate the action plan.

Different stakeholders may be invited to each of the four different workshops, but they will generally be drawn from representatives of the AVC actor groups, the steering panel, and experts and government representatives of the agricultural sector. Other stakeholders could include **service providers** such as input suppliers, extension agents, and financial intermediaries; traders and exporters; and industry, producer, and women's organization representatives with the skills and capacity to guide the study; **NGO, local and national government representatives** (e.g., from agriculture or environment ministries); and **public and private sector representatives**, from different links of the value chain, such as farmers and major companies.

STAKEHOLDER WORKSHOPS IN DETAIL

Find it: Detailed information on planning and holding the Stakeholder Workshops, with details on each of the four different workshops is in **Annex A**.

AVC-RAS Literature Review and Data Analysis

A literature review and data analysis are necessary to better understand the overall knowledge, and the data, that has been compiled on agricultural risks and how they impact the selected value chains. It serves as the first step for the team to gain the basic information and an overview of the value chain analysis, the risk assessment, and the vulnerability assessment. This literature review also brings together the necessary information to write the country agricultural sector risk profile. It also provides the analytical context for characterizing the AVC, risk analysis, ARM solutions inventory, and analysis of actors' capacity to manage risks. While these topics build on each other, the tight time frame does not permit performing the analyses in sequential steps. However, since the emphasis is typically on one country and several value chains within the country, it is feasible to look for both literature and data at the same time. To inform and align the overall analysis, team members engaged in research for the different work streams can regularly exchange their findings.

LITERATURE REVIEW AND DATA ANALYSIS IN DETAIL
Find it: Detailed information on the literature review and proposed sources can be found in **Annex B**.

Interviews with AVC Experts and Actor Groups

Interviewing experts and key actors is an iterative process that can extend throughout the study. There are different types of experts to be interviewed, with different perspectives on the value chain, and the types are summarized above in the section on stakeholders. The objective of the interviews is to gain a better understanding of stakeholders' roles in the AVC, their perceptions, and their estimations of risks they face and their capacity to manage them. Fieldwork, or site visits to the places where AVC activities take place, such as cooperatives, rural and urban wholesale and retail markets, and logistics hotspots, can provide valuable information. Traveling to these locations can furnish a deeper understanding of the local context and enable spontaneous chats or interviews over and above planned interactions. In the early stages of the project key informant interviews can help the AT select AVC(s) to analyze by exploring links in the value chain, essential services and service provides, and the most important direct actors. Field visits to AVC sites can provide information on significant historical risk events that have impacted an AVC and on actors' perceptions of their risk exposure and the consequences these risks have had for their livelihoods, in terms of business and productivity losses. They can also identify risk management strategies, and in the final weeks, interviews are used to finalize the action plan. It should be noted that the assessment team is bound to rules of ethics, and ethical clearances may be required to ensure the rights, safety and protection of the those interviewed and their personal information. Ethics clearances can be requested with the own institutions' internal review board, ethics committee or from national, regional or local government offices. More information on interviewing and examples of questions is in Annex C.

INTERVIEWS WITH AVC EXPERTS AND ACTOR GROUPS IN DETAIL
Find it: Detailed information on conducting interviews in order to close information gaps can be found in **Annex C** and **Annex H**.

Outline and Workplan of a Agricultural Value Chain Risk Assessment Study

Chapter Outline of the AVC-RAS

The following chapters provide the instructions for each of the activities that contribute to the AVC-RAS report. They also indicate when the AT will be ready to draft various portions of the report, along with detailed information about what to include in each subsection. In general, we recommend that after completing various milestones, often taking the form of stakeholder workshops, the AT should draft corresponding components of the AVC-RAS report when the relevant information is fresh in mind. At the end of the whole process, it is necessary to compile these components into a single document, revisit that draft, and polish and update it as appropriate before publishing or otherwise disseminating the finalized report.

The final AVC-RAS report follows this structure:

1. Background
   a. Purpose and setting of the study
   b. Country context
   c. Risk profile of the country's agricultural sector
   d. Selected value chain(s)
2. Value chain risk analysis
   a. Risk Assessment
   b. Inventory of existing ARM solutions
   c. Capacity and vulnerability
   d. Prioritization of Risks and Actors
3. ARM strategies
   a. Gap analysis
   b. ARM strategies
   c. Action plan
   d. Monitoring and evaluation
4. Methodologies and sources

More information on the content of these chapters can be found **in following chapters** and the Writing Guidelines in **Annex G**.

Timing of the AVC-RAS Components

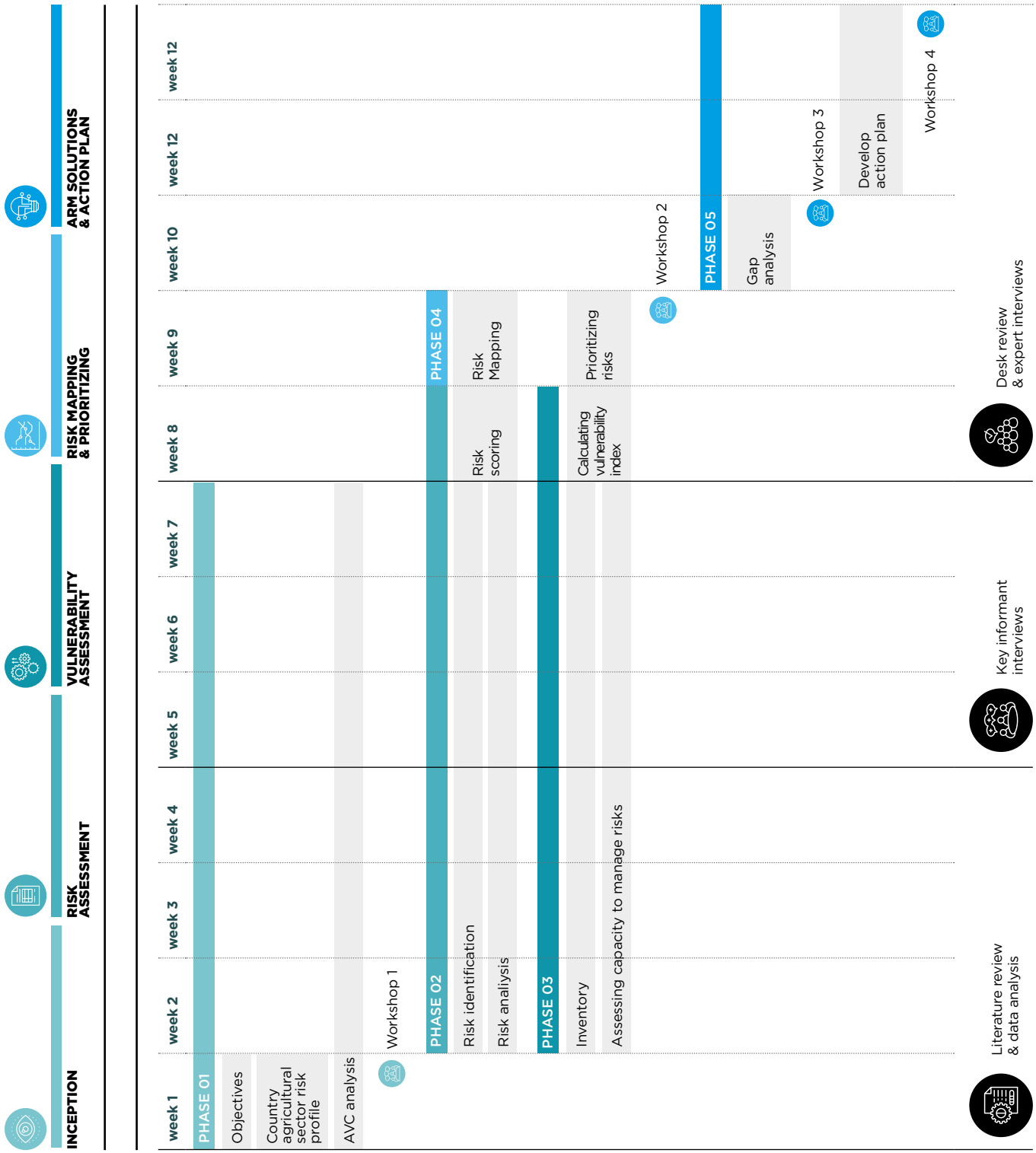
As illustrated in Figure I.3, the AVC-RAS is expected to start the AVC-RAS with an initial phase of defining the objectives, getting an understanding of the agricultural sector risk profile and simultaneously performing a rapid analysis of the selected agricultural value chains (AVC). The work plan foresees that Workshop 1 is kicking off the study at the end of week 1. Most of the time allotted for this AVC-RAS is preparing needed inputs to workshops

2 and 3 in weeks 9 and 10. In these workshops, participants make all-important decisions on prioritizing risks and risk management solutions. From week 2 to week 4, the tight time frame requires literature review and data analysis for completing the AVC characterization, risk analysis, ARM solutions inventory, and analysis of actors' capacity to manage risks to happen in parallel. The literature review should be complete by week 5. This allows time for fieldwork and an extensive interviewing, based in part on information from the literature review, with key informants and actors for each AVC with questions characterizing each AVC, the risk analysis, actors' capacity to manage risks, and identifying solutions. This should be completed in week 7. Once this phase is complete, this work plan proposes two weeks to synthesize, visualize, and interpret the data prior to workshop 2. Then, one week is planned to conduct the gap analysis on ARM solutions which leads the team to workshop 3 at the end of week 10. If the AT prefers to conduct less workshops, workshop 2 and 3 could be merged. A final round of interviews and secondary research in weeks 11 and 12 furnish opportunities to prepare for the capstone workshop at the end of week 12.

The workplan in Figure I.3 shows how activities can be organized across the time frame. In the first week, the content of the first chapter of the AVC-RAS report can be drafted. The content for the second chapter of the AVC-RAS report will be ready after workshop 2. Finally, the third chapter of the report can be composed after completion of workshop 4. It is recommended to write-up sections of the report the earliest possible. Writing guidelines can be found in Annex G.

The structure of this toolkit follows the stages of this process. Specific steps are detailed in boxes within sections, along with where to look for the exact "how to" in the Annexes. This main section provides an overview of the whole process.

Figure I.3. Suggested work plan for the AVC-RAS.



Phase 1

Inception

Objectives

Country agricultural sector risk profile

AVC analysis

INCEPTION
WORKSHOP 1

Phase 1
Inception

This chapter summarizes the 3 preliminary steps in an AVC-RAS that are proposed to take place in the first week of the AVC-RAS:

1.1 **Objectives, scale, and scope** of the study are key.
1.2 **Country agricultural-sector risk profile** is a concise description of the country's agricultural sector and its known risks based on literature and secondary data.
1.3 **Agricultural value chain analysis** is analyzed based on its characteristics, and the units for the subsequent risk analysis are defined.

1.1. Objectives, scale, and scope

Different agricultural sector clients may have different objectives that entail various scales and scopes of interest, given the clients' capacities and priorities. The relative importance of risks depends on how objectives are defined, so **the first step is agreeing on key objectives** that can orient the AVC-RAS. Clients typically pursue objectives such as: a) promoting agricultural sector competitiveness and resilience; b) stabilizing or protecting the agricultural gross domestic product (GDP) or exports, c) promoting food security and nutrition; d) reducing the vulnerability of a strategic value chain or e) improving the conditions of vulnerable groups. Choosing a maximum of two objectives for a study reduces the complexity of the process and provides better results.

Clearly defined boundaries help guarantee the success of an AVC-RAS. Given the complexity of the agri-food system, teams may encounter a wide range of elements that vary in scope, resolution, depth, commodities/products, topics of interest, actors, stages, and other aspects. Defining clear objectives, the scale, and the scope of the study creates boundaries that keep the assessment manageable. This process usually occurs at the study's formulation stage through consultations between the AT and clients, with input from other stakeholders. Yet "it is possible that the clients' priorities and objectives change half-way through a project's implementation; additionally, clients tend to overload projects with a wish list of expected results, and it is unrealistic to expect that these types of initiatives can serve everyone's priorities (ILO 2015)." Adhering to the objectives, scale, scope, time, and resources available is possible by limiting the number of priorities and clearly distinguishing between "must-haves" and other interests. Delineating the objectives early will also prevent the AT from being influenced by the multiple interests of AVC stakeholders participating in the study´s activities.

The AVCs to be reviewed with this study need to be selected before the study starts. The AT needs to clearly define which AVC(s) and which part of the AVC(s) are in scope of the study. Clarifications should be done at an early stage with the client or the steering panel.

An inception workshop is the "public" starting point for bringing key stakeholders together to agree on the process and objectives of the AVC-RAS. The purpose of the inception workshop is to kick off the AVC-RAS process and selection of risk assessment parameters such as criteria for impact and probability scores. In most cases, the objectives and scope might already be decided, and the workshop is rather used to get all the stakeholders on-board and involved into the discussion.

The **geographic scale of an AVC-RAS needs to be defined at the inception workshop**. Because value chains can be spread over different spaces, an AVC-RAS can be conducted at different geographic scales, such as regional, national, landscape, catchment, provincial, municipal, etc. Determining a scale will influence data availability, data collection methods, and the set of stakeholders to include. It is also important to clarify whether an AVC analysis will track a commodity across all of its life stages, since the relevance of the agricultural commodity may change with geography or the stage of production. For example, the client may only be interested in an analysis of a country's sugarcane value chain up to its first processing stage or to the point of export. As sugar and other sugarcane sub-products and by-products become inputs for different national and international industries further downstream, the geographic extension, risk management options, and more importantly, stakeholders' interest and capacity for engaging in coordinated risk management strategies may diminish considerably. This is especially true when the agricultural commodity is less relevant for the industry´s final product since there may be substitutes available or alternative sourcing regions. For simplicity, this toolkit is assuming a geographical scale that doesn't cross national boundaries.

Whether the suggested work plan is feasible depends, for example on the following criteria:

- **Objectives, scope and scale:** The more objectives and the larger the scope of the study, the more time should be budgeted to perform the various tasks.
- **Number of AVCs selected:** Data collection through interviews with AVC actors and data analysis will both take longer with each additional AVC that is included. For this AVC-RAS, it is recommended to only select one or two AVC.
- **Data availability:** With more data available, richer analysis becomes possible. Yet time restrictions necessitate a narrowing of analysis methods. The time set aside for interviews cannot be reduced since they are key to several steps of the AVC-RAS and cannot be replaced by data analysis.

1.2. Country agricultural sector risk profile

By first attaining a good understanding of the general context of the agricultural sector in the geographic area of interest, the AT will acquire key information about the importance of agricultural activities and selected agricultural value chains (AVC) and will also gain an overview of the sector's structure and important trends. The AT can conduct a rapid review of relevant indicators for the agricultural sector based on secondary information or a few relevant reports. This research will be summarized in a short, concise (e.g., 2-3 pages) profile of the country's agricultural sector. This country context constitutes the first subsection of the introduction to the final AVC-RAS report. A broad overview of relevant risks based on secondary literature constitutes a second subsection of the AVC-RAS report's introduction. Considering the tight schedule for an AVC-RAS, the country context and the risk profile take about a week to write and can be done in parallel with characterizing the AVCs.

Incorporating gender dynamics and gender inequalities, when relevant and known, into the agricultural-sector profile will enable deeper understanding of the sector. The agricultural sector profile should provide information on the following key aspects:

- **importance and trends of the food and agricultural sector** for the country's GDP, employment, imports, and exports;
- **drivers of poverty and malnutrition** and their trends, especially in rural areas;
- **major agricultural sector characteristics**, such as agroclimatic zones, farm size, the share of subsistence farming, and irrigation;
- the influence of production structure on risk exposure;
- **the main risks for the agricultural sector**, if they are available in the literature, and corresponding government programs or strategies;
- **major commodities** among crops, livestock, fisheries, and forestry; their production and trends; their relative importance for vulnerable populations; and any significant gender differences relevant to these commodities;
- **employment level and the share of small-scale farmers** for each major commodity and zone, use sex-disaggregated data if possible;
- **gender inequalities** and the role of minorities as well as of people of different ethnicities and ages, for example.

Note that tables may be a useful way to convey this information both fully and efficiently. Best practices are to highlight key findings and trends in tables without a line-for-line retelling of a table or spreadsheet. Subsequent chapters will address the risks on the value-chain level.

INDICATORS AND SOURCES FOR COUNTRY AGRICULTURAL SECTOR RISK PROFILE IN DETAIL

Find it:

- **Annex B.5** proposes indicators and sources that could be relevant for this step.
- **Annex G** provides guidelines for the write-up of the final AVC-RAS report.

1.3. Agricultural value chain (AVC) analysis

The characteristics of selected agricultural value chains (AVCs) need to be understood before the risk analysis along the AVC can be started. An AVC includes all the processes and actors involved to move an agricultural product from the farm to the customer or consumer. This includes the exchange of goods, services and information through multiple channels, often across large territories, influenced by external forces and the actions taken by the actors. Taking a value chain approach requires understanding the system in its totality; all the firms that operate within the sector: input suppliers to end market buyers to the support service providers and the environment in which the firms operate (USAID, n. d.). One week is too short for an extensive analysis. Therefore, the AT needs to prioritize researching and analyzing the relevant elements needed for an AVC-RAS. The subsequent weeks will further allow to fill gaps in the AVC analysis, and complement the information gathered in the first week.

An AVC analysis serves as the framework for the AVC-RAS by:

- describing the **overall context** of how the value chain functions – for instance, with regard to its structure, end markets, actors, activities, and product flows;
- setting the boundaries of the analysis;
- identifying AVC groups of actors to interview, also referred to as the **units of analysis**;
- providing descriptive and quantitative data to inform the risk prioritization and ARM solutions, by identifying the most important market segments, value chain channels, vulnerable actor groups, and support services provided.

The seven crucial themes to elaborate in an AVC analysis can even make up a table of contents for this section of an AVC-RAS report, providing descriptions of:

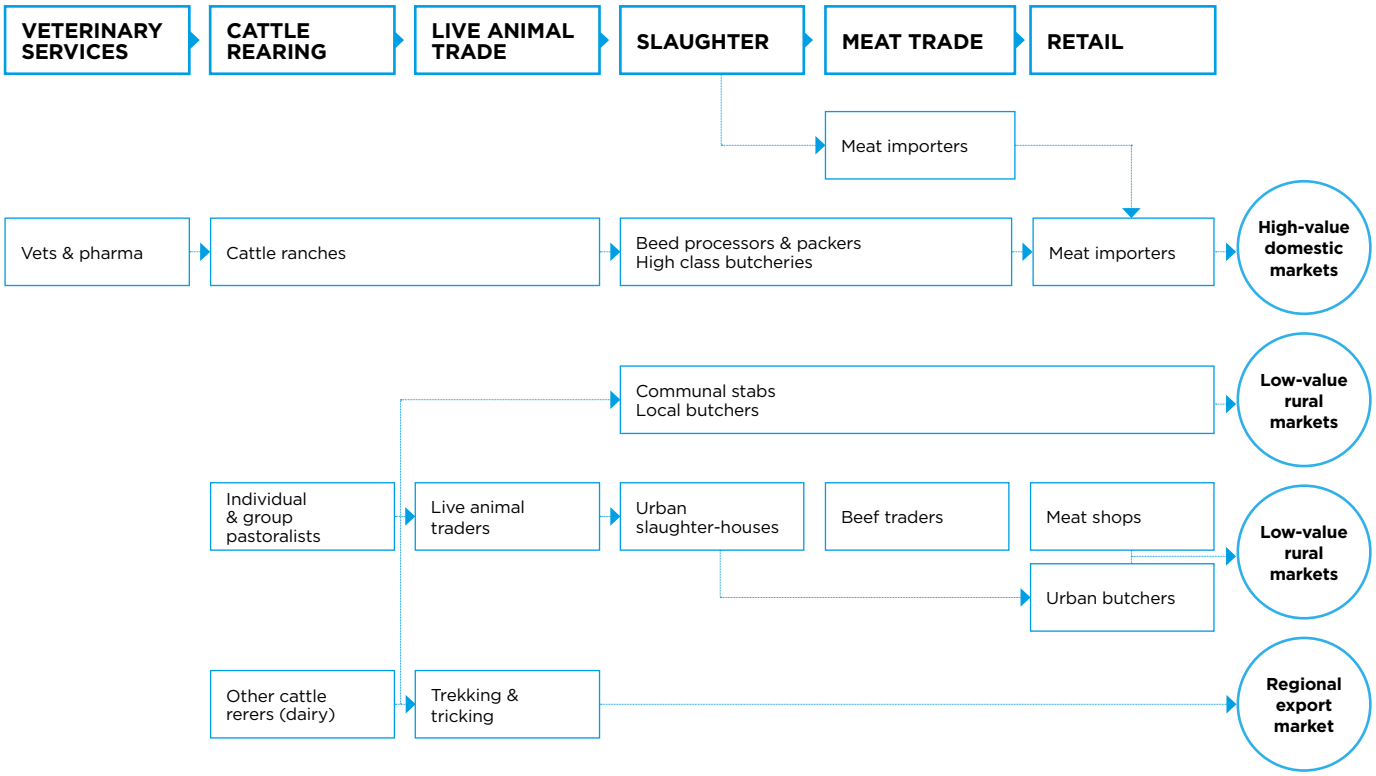
1. AVC commodity
2. Value chain map
3. End Market Analysis
4. AVC stages and direct actors
5. Support services
6. Geographic analysis
7. Social and gender issues

1. The **AVC commodity** briefly introduces the main characteristics of the primary product. These characteristics include its ecological requirements regarding soil type, nutrients, temperatures, and precipitation; its productive cycle and productive seasons; and a brief overview of the relevance of the product to the economy, for instance the share it contributes to the agricultural GDP and to employment.

2. A **value chain map** visually represents a value chain and is one of the fundamental elements of the AVC analysis. It depicts the stages, actor groups, product flows, and the support service providers involved at each value chain stage. The map gives an overview of the system and helps structure information on the functions and stages of the chain. The map helps people visualize the actors, their interrelationships, and the production channels in the value chain. It supports the AT in prioritizing units of

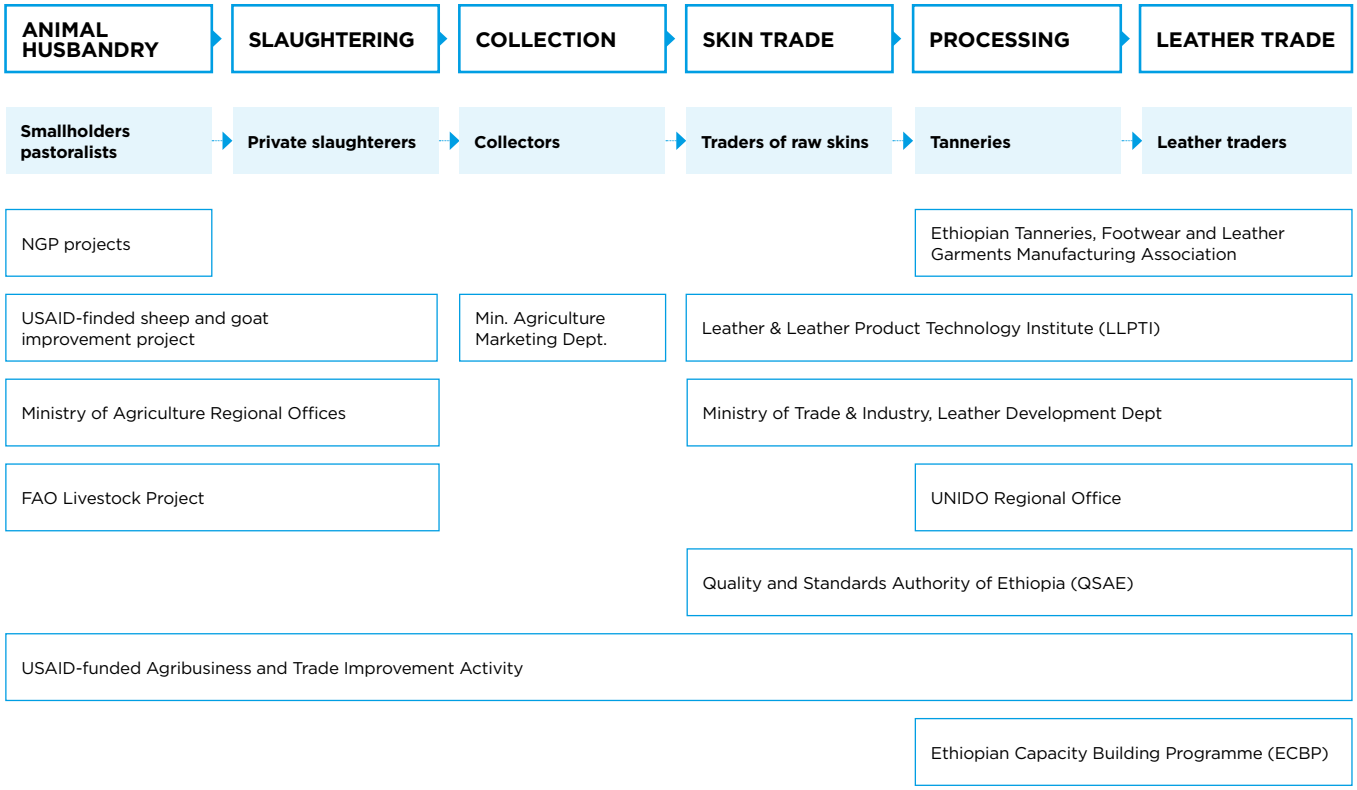
analysis and paths of risk transmission. Figure 1.1 provides an example of a typical value chain map for beef. The channels with arrows highlight different supply flows and the corresponding types of actors involved. In this example, we observe a first channel that leads to high-value domestic meat markets, a second channel to low-value rural markets, a third channel to low-value urban markets, and a final channel for the regional export market. A value chain map may depict meso and macro level actors in an additional graph; placed adjacent to the relevant value chain links they serve (Figure 1.2).

Figure 1.1. Example of a basic beef value chain map.



Source: Springer-Heinze (2018)

Figure 1.2. Example of a basic beef value chain map.



Source: Springer-Heinze (2018).

The value chain characterization includes the narrative and descriptive information about the value chain, with a detailed description of each AVC stage and its corresponding activities, supported with quantitative and qualitative information about the number and type of actors, input and product flows, and business relationships. The characterization should also include maps of production areas and the locations of relevant stakeholders and a description of social and gender characteristics of the main actors.

3. The **End Market Analysis** gives a broad understanding of the global and local markets for the product or service of interest. The effects of changing demand dynamics, policies, and regulations, and other sources of volatility, can significantly inform the analysis of market risks. We recommend conducting a swift market overview based on secondary information that identifies current customer segments, product characteristics, the distribution channels of end products, and the most important market trends. This can be done by reviewing available databases, market research reports, and if needed, interviewing local stakeholders and industry experts. The end market analysis should provide answers on:

    - the size and dynamics of the most important end markets and market segments (information needed to compare AVCs during risk prioritization (chapter 4).

- if major markets are domestic or international and their location which helps identify relevant logistical and policy risks (section 2.2).
- the prices and price dynamics of the most important end products, and how the products reach consumers (enabling assessment and understanding of market and logistics risks) (section 2.2).
- the main actors in producing and distributing end products helping identify the most important and vulnerable actors, market and logistics risks (section 2.2), and prioritizing risks and risk management strategies (chapters 4 and 5).

4. Describing **AVC stages and direct actors** defines the units of the AVC-RAS. The generic stages and actors that are common to most AVCs can be used as reference and adapted as required:

- **Producers** includes actors involved in the primary production of the AVC commodity; they may be further categorized by the size of the enterprise, technology and marketing channels among others.
- **Aggregators** and intermediaries include formal and informal actors whose main activity is to trade and broker the AVC commodity,
- **Processors** include formal and informal actors involved in processing the agricultural commodity. It may involve first or further transformations into higher added-value products along the value chain.
- **Exporters** include primarily the exporters of the agricultural commodity in its raw state or with low value addition. Exporters of processed products are better depicted in the processing stage or in a separate exporting category.
- **Distributors** are wholesalers or retailers who trade the commodity or finished product directly or almost directly with the final consumer.

Defining **the stages depends on an actor group's characteristics and business operations.** For example, if producers in a particular value chain trade directly with processors and wholesalers, it is irrelevant to consider a stage of intermediary trade. Yet some AVCs will also significantly involve additional stages such as input and seed supply or export. Some direct actors also play the role of service providers to other direct actors, such as cooperatives that act as traders that also provide financial services and technical assistance. In that case, both types of operations can be assessed for that particular actor according to the interview questionnaire in Annex H. Since primary production is often the most vulnerable link of the AVC, we recommend a more thorough description of the sector's farm structure, farm sizes, typical productive systems, seasonality of production, and if possible, cost structure, farm gate prices, and income sources. Information regarding food and nutrient losses along the AVC may feature in this section, depending on the study's objectives.

The **names and typologies of the most relevant direct actors at each stage** is key information. It includes the number of actors for each identified typology if possible, or at least rough estimates of the percentage of total actors. It also discusses their location, the products and subproducts derived from their operations, product prices, traded volumes, the main customers and suppliers, trading channels, and types of commercial arrangements. While secondary information may address these topics, it can be verified

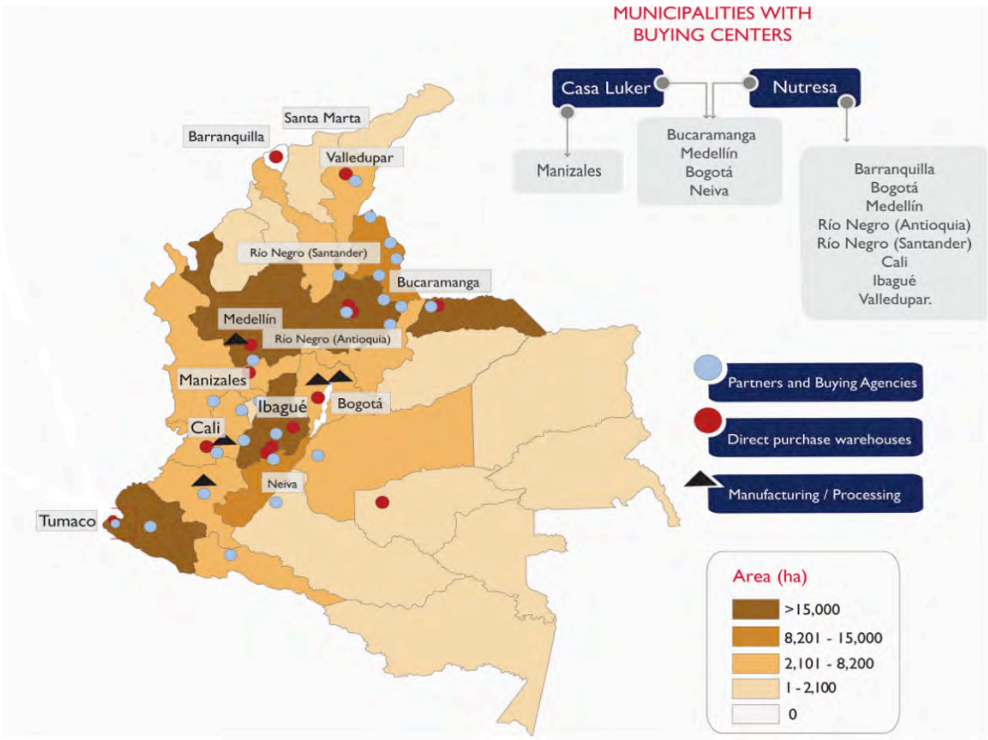
through key informant interviews. These interviews can also identify the most relevant services and service providers for each stage and may provide information on a rapid assessment of their frequency of use, importance, quality, availability, and perceived cost-benefit ratio of these services.

These **key actors form the key units of analysis** relevant to the selected AVC, and they are the basis for all subsequent steps of the risk and vulnerability analysis. An assessment of the risk exposure and vulnerability is needed for each unit/actor group, so these should be chosen wisely based on the characteristics of the AVC, although in some AVCs, it may be important to consider vulnerable groups (see 7, below). Defining separate groups can reveal differences in actors' risk landscape and capacity to manage risks. The analysis can describe the characteristics of each group of actors, including their gender ratio, age composition, average farm or business size, ethnicities, and locations at broad scales (not household level). It is best to limit the number of AVC actor groups as units of analysis, e.g., to maximum 7 or 8 groups. Separate risk analysis needs to be performed for each of the actor groups, and some of these may be further analyzed by gender. There is a need for balancing the depth of the analysis and the workload.

5. **Support services** identify the most important support and operation service providers. These actors will be key to assess and implement risk management solutions, and their performance is crucial to the AVC's capacity to manage risk. Service providers usually consist of a mix of NGOs and private and public actors. Analyzing support services focuses on providers of financial services, agricultural insurance, technical assistance and training, agricultural research and development, and transport and logistics. A brief, general description of their activities, areas of influence, main customers, challenges for service provision, trends, the growth of their sector, and types of ownership (such as public, private or mixed models) is included based on their importance to the value chain. Macro-level actors such as governments and regulatory entities – both national and international in case of exports – can be included if their roles and influence in the value chain are explained. The most relevant support services to AVCs are typically the ministries of agriculture, environment, trade and industry, and health, and national and regional governments, entities in charge of zoo sanitary and phytosanitary control, and environmental agencies.

6. **Geographic analysis** is an essential complement, depicting productive areas and the main trading and processing centers. This provides a useful context, and aids in visualizing potential logistical and agroclimatic risks. Maps should be used to identify the most important productive regions and the location of major processing and trade centers. Information about roads can also help identifying potential bottlenecks and estimating the severity of risks related to roadblocks and infrastructure damage. Figure 1.3 shows an example that displays geographical details of cocoa production, trade, and manufacturing in Colombia. In **Annex J**, more information about mapping agroclimatic conditions can be found.

Figure 1.3. Distribution of cocoa production, purchasing, and manufacturing centers in Colombia.



Source: Abbott et al. 2018

7. **Social and gender issues** are closely linked to vulnerability, with a need to understand how different social groups, women, and other vulnerable groups deal with empowerment, decision-making, and access to capital and services. Identifying the roles, characteristics and locations of vulnerable actors such as minorities or impoverished groups can be a fundamental client priority, and these AVC actors usually fall into one of three categories: a) poor, small-scale self-employed operators, including small producers, processors, and traders; b) poor wage workers in agriculture, agroindustry, and businesses; and c) poor consumers in markets served by the value chain. Poverty mapping helps identify and characterize poor operators by:

- **Classifying poor operators** by size, production methods, assets, volumes of production, or types of commercial relationships;
- **Identifying the different sources of income** of poor operators, and the share of their income from AVC activities;
- Noting **relevant workforce differences**, e.g., between temporary and permanent workers;
- **Identifying AVC workforce participation** of marginal or other priority population groups, such as children or illegal immigrants, and if so, under which conditions.

Gender-related differences need to be analyzed at different levels across the AVC (FAO, 2016a). This helps in understanding the roles and structural differences between genders along the value chain to better pinpoint risk exposure and mitigation strategies. For example, in Ghana, women are typically the producers and traders of agricultural commodities, whereas men trade other products that require more capital and resources but also provide higher profit margins, and men control wholesaling, with consequences for risk exposure and sensitivity (Pepper, 2016). In some countries and regions, women farmers have greater exposure and vulnerability to hazards than men farmers because of a variety of factors: growing different crops, the division of labor, or lower access to high-quality inputs and knowledge about techniques and crop types to increase their resilience and reduced access to financial services and markets. Indeed, women can have a systematically different exposure to risks than men even when growing the same crops (PARM, 2019b). Therefore, understanding different gender roles and the demographic distribution is fundamental to assessing gender-related risks and their potential impacts on those groups and the entire AVC.

Including gender in the AVC can start with consulting available statistics and information on gender division of labor and actor distribution along the value chain, especially among producers and wage workers. It is possible to identify roles and activities that are carried out primarily by men or/and women and that determine control of assets and decision-making, which helps define which links of the AVC should be disaggregated by gender. Data availability may pose a limitation, and data may only be available per farm or farming system. Yet an AVC-RAS is focused on the entire AVC and on covariate risks that often impact the entire community or large groups of value chain actors. When analyzing individual-level data, only systematic effects across the group of AVC actors should be considered.

METHODOLOGIES FOR AVC ANALYSIS

Find it:

- **Annex B.1** proposes a list of literature that can be consulted for more information about AVC analysis.
- **Annex G** provides guidelines for the write-up of the final AVC-RAS report.

Phase 2

Risk assessment

Risk identification

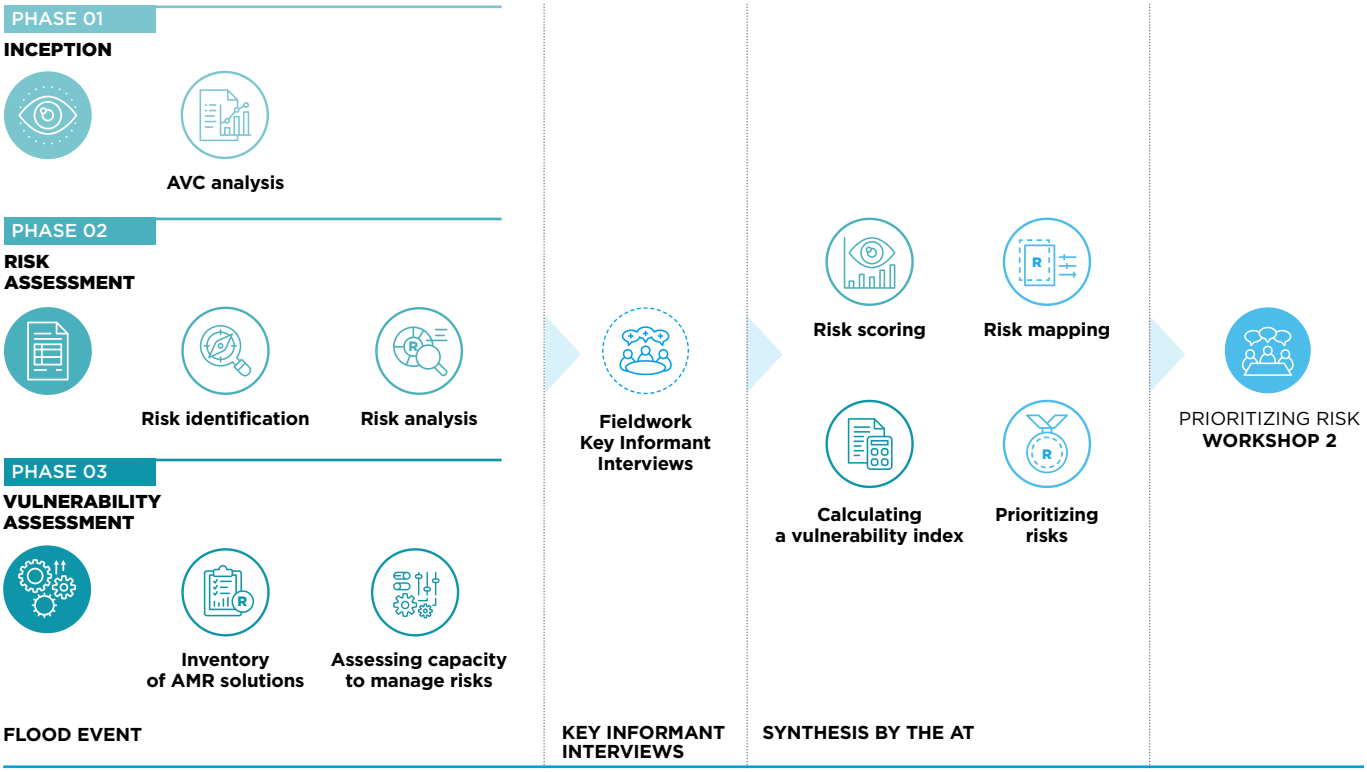
Risk analysis

Risk scoring

Phase 2
Risk assessment

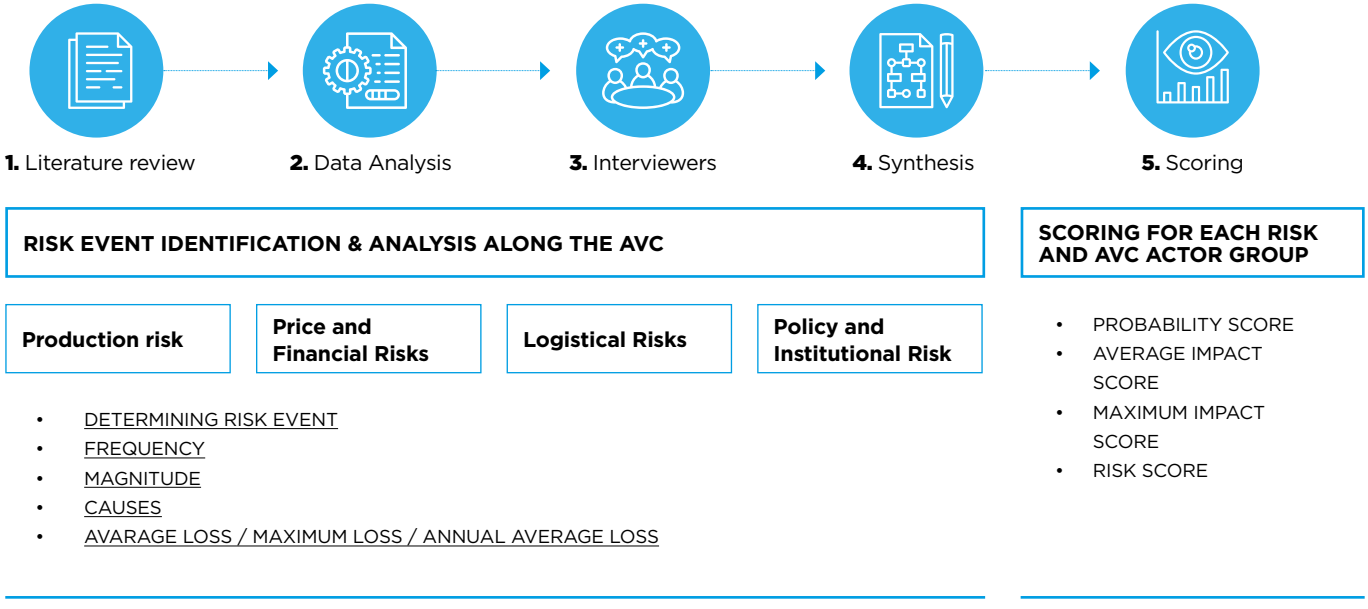
This chapter focuses on the risk assessment, describing the steps of risk identification, risk analysis, and risk scoring. Completing the characterization of the AVC and assessing actors' capacity to manage risks (CMR) are actions that happen simultaneously, as shown in Figure 2.1. A 3-week phase of desk review informs the AVC characterization, the risk assessment, and the assessment of AVC's CMR. The desk review is followed by another 3-weeks phase of interviewing and fieldwork which needs to be performed at the location of the selected AVCs and complements the desk review. After the fieldwork, the Assessment Team (AT) has two weeks to synthesize all the information collected and visualize the results. Then, the team concludes the core work of the assessment with a workshop on prioritization and solutions.

Figure 2.1. Visualizing the assessment phase.



The five steps for a risk assessment for a single AVC are shown in Figure 2.2. If there are multiple AVCs, this process is replicated for each.

Figure 2.2. Visualizing steps 1-5 of the risk assessment.



The following overview summarizes the risk assessment process.

1. In a first step, the literature review for each AVC and AVC actor group needs to be completed and a **comprehensive list of identified risks** is prepared for each AVC, with information about affected AVC actor groups.
2. **Analyzing the risks** may require additional literature review and data analysis to gather information about probability and impact of risks on the AVC and correlations, underlying causes and dependencies.
3. Fieldwork and interviewing key informants and representatives of each AVC actor group complements information gathered to date.
4. **Synthesis is done for each AVC, each risk, and each actor group**, and the team discusses the information collected and reaches conclusions on estimating risk frequency and measuring losses to arrive at risk scoring.
5. **Scoring is estimated for the probability and impact of each of the identified risks** by the AT. For each AVC, the risk assessment output is a list of specific risks that scores the probability on a scale of 1-3 and the impact on a scale of 1-5 (Table 2.1). The scoring results form the basis for calculating the vulnerability index in Chapter 3 and for the risk prioritization in Chapter 4.

Table 2.1. Example of output from the risk assessment.

Risk	Probability	Impact
Risk 1	3	2
Risk 1	1	3
Risk 1	2	5
...		

The following activities provide a catalogue of potential methods to analyze risks. The AT needs to focus on the key risks and is required to prioritize risks depending on their relevance along the process. Every prioritizing decision should be done based on professional judgment, considering available information about the risk, which in many cases would be expert opinions gathered through interviews.

2.1. Risk identification

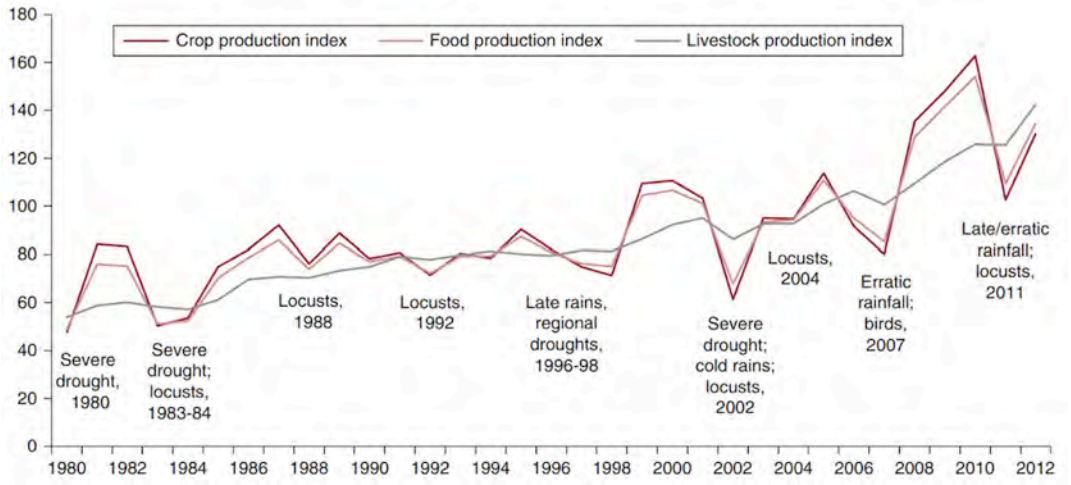
The goal of risk identification is developing a long list of risks with their timeline along the AVC. This is done though literature analysis, secondary data analysis, and interviews with AVC actors and key informants. It typically occurs during weeks 2-7. Identifying risks includes determining hazard events, including changes in circumstances, sources and causes of risk, areas of impact, and potential consequences (ISO, 2009b). For this, information about the value chain's risk exposure needs to be reviewed in a first step, and a long list of relevant risks should be composed as a basis for further analysis.

Step 1 – Identifying risks is done by learning about the causes and effects of risk events in the AVC. A risk is relevant if its adverse effects on the AVC are relevant. Attention needs to be given to the client's objectives in the AVC (e.g., stable production, food security), with a focus on identifying the risks that jeopardize achieving these objectives. Risks can be identified by learning from past experiences, since most value chains have experienced past adverse events. The underlying hazard needs to be identified to understand the risk event. Hazards can be defined as the physical origins of a risk. A hazard becomes a risk only when it is paired with the AVC's exposure to it. These hazards can have an impact on different geographical scales.

Step 2 – Compose a comprehensive list of risks that threaten clients AVC objectives. The Assessment Team should be mindful of the total number of risks identified and rank them by relevance to keep the time frame and efforts under control, and the short-list of risks identified in Workshop 1 can be a guide. Yet the AT should compile a long list of risks as a basis for further analysis, with reasons for selecting these risks justified and documented. It is beneficial to the analysis to specify and describe the risk event accurately in terms of underlying hazard, timing (season, duration), and effect on the AVC.

Step 3 – Develop a timeline of risk events, based on the literature review, that shows significant historical risk events affecting the AVC. Figure 2.3 features an example at the sectoral level. If data is available, a similar timeline could be created for different geographical areas, actor groups or agricultural value chains.

Figure 2.3. Timeline of Major Shocks to Agricultural Production in Senegal (2004-06=100), 1980-2012.



Source: D'Alessandro et al. 2015

RISK IDENTIFICATION STEPS IN DETAIL

Find it: Detailed information on the process of risk identification is in **Annex D.1** and guidance on the performance of interviews can be found in **Annex C**.

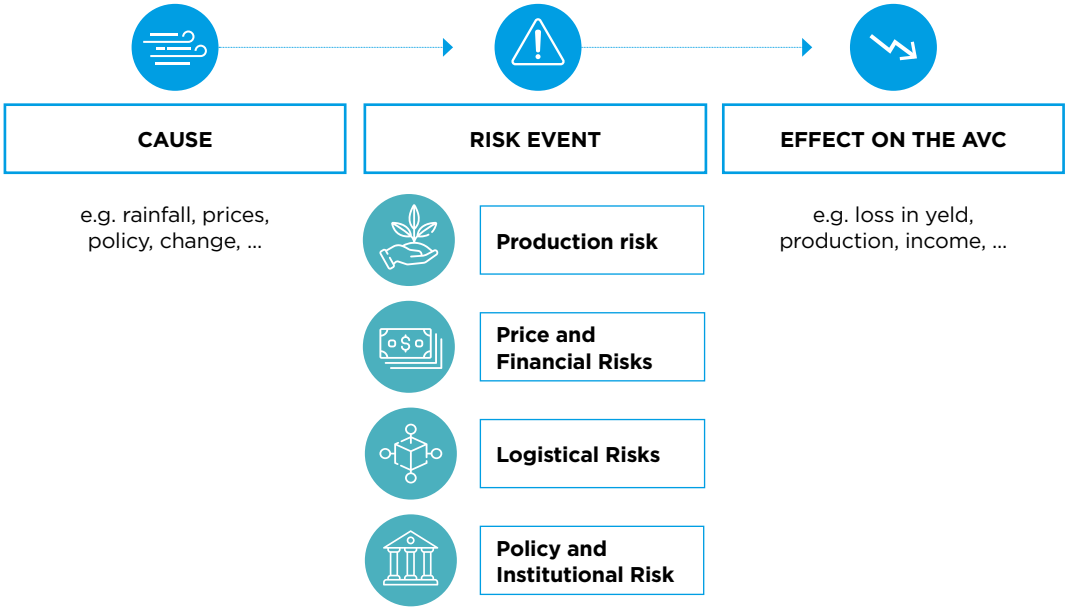
2.2. Risk analysis

The **goal of risk analysis is estimating the probability and impact of identified risks**, based on appropriate in-depth analysis done though data analysis, interviews with AVC experts and actors, and selected methods dependent on the identified risks. Risk analysis typically occurs on the basis of the list of identified risks until week 7. The aim of the risk analysis is to provide a deeper understanding about AVC risks as a basis for later evaluations and decisions. The main objective is assessing the probability and impact of each risk. If data availability allows it, the assessment can be done for each value chain actor group of each value chain under review. Ideally quantitative information or estimations are identified for each risk and AVC actor, including:

- **probability of occurrence**,
- **magnitude of the hazard**, for example, the geography, the extent of the event,
- **the people/actors affected** such as farmers, processors, traders, and others,
- causes of the risk, and
- **average loss, annual average loss, and maximum loss** in terms of production, prices, income, product flow, and other setbacks.

Analyzing the probability that a risk will occur and the extent of its impact, including a risk's causes or underlying hazards and its' effects, is essential. Figure 2.4 shows that the **risk analysis entails assessments of different datasets**, depending on whether the risk's causes or effects are analyzed. This simple cause-effect logic helps structure and categorize the different activities in the analysis and select required datasets. These various datasets can be analyzed using similar or different methods, depending on the types of data. If available, datasets on both hazards and their effects, such as production or price data, should be analyzed for understanding and estimating probability and impact.

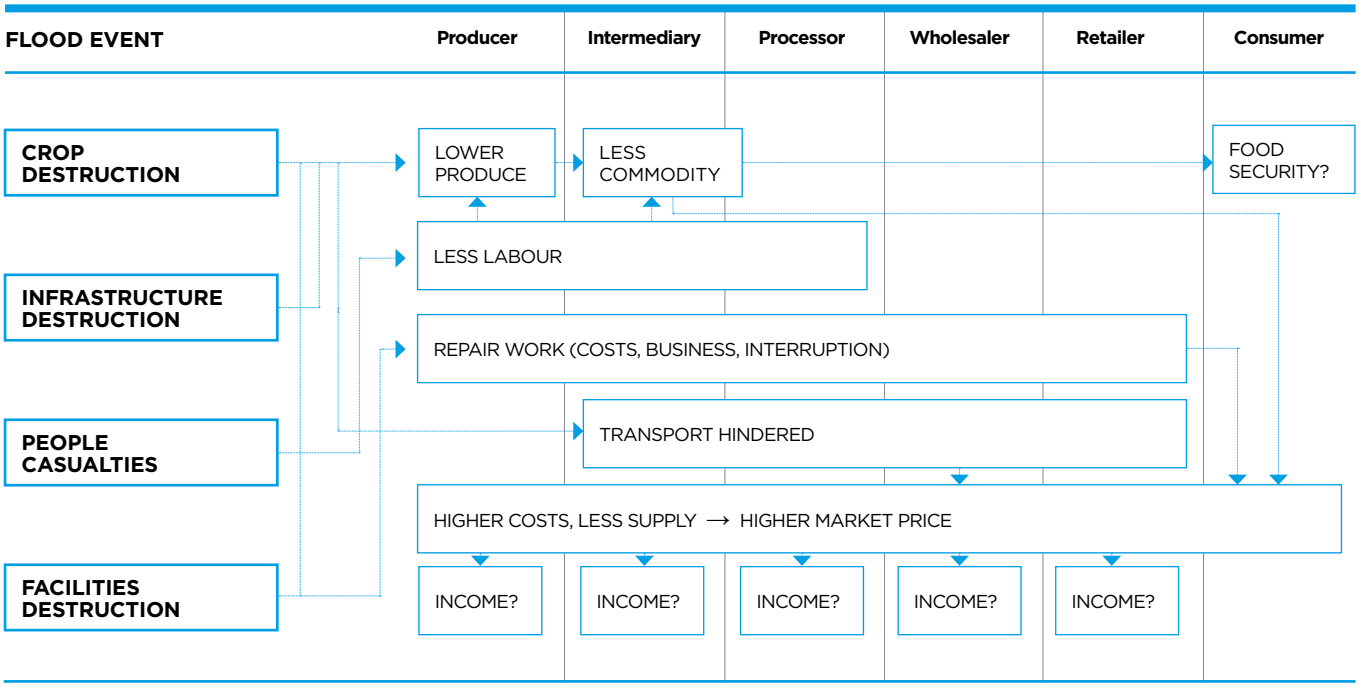
Figure 2.4. Scope of the risk analysis.



Each of the risks could be analyzed in detail, although a tight time frame might require selecting specific risks to be analyzed in more detail. The AT might focus the data analysis on yield time series analysis, and analyzing a few specific known risks, such as a particular weather events or price fluctuations in more detail. For the subsequent step of Risk Scoring, it is crucial to achieve an estimation of probability and impact for each risk that should be part of the later risk prioritization. However, data might not be available for many risks and their effects on AVC actor groups. Any remaining gaps and missing estimations can be gathered through interviews with AVC actor group representatives and AVC key informants. Methodologies and instructions on how to quantify the risks or estimating them can be found in Annex D.

Interviews with AVC actors can also help identify relationships between risks and their effects on various actors in the value chain. To analyze the causes and effects of risks across the value chain, the AT can draw impact pathways to visualize the relationships by using the template in Annex E or flow charts. An example of a flow chart is shown in Figure 2.5. These can be especially useful in conveying complicated information to stakeholders that might not be used to reviewing quantitative results.

Figure 2.5. Example of an impact pathway (for illustrative purposes only).



Impact pathways or flow charts can clarify and explain how risks are related and who they affect in which ways. They help prevent under- or overestimations of the effect of a single risk on the AVC and help in formulating effective risk management strategies. The AT should describe correlations and transmissions of risks along the value chain in the AVC-RAS report.

RISK IDENTIFICATION STEPS IN DETAIL
Find it:

- **Annex B.6** contains a table of indicators and datasets that could be relevant to the AT for the data analysis.
- **Annex D.2** describes the process and methodologies of risk analysis in detail.
- An excel spreadsheet in **Annex I** can support organizing and interpreting the results of the risk analysis.
- **Annex B.9** contains a table of datasets that could be relevant for analyzing weather risks.
- **Annex B.10** contains a table of indicators and datasets to assess price risks along the AVC.
- For a specific analysis of weather risks, **Annex J** can be consulted where an open-source interactive notebook for running a weather model is introduced and its application is explained.

2.3. Risk scoring

The **goal of risk scoring is assigning scores for probability and impact** to the identified risks through steering panel meetings, AT's preparation and judgment. This typically takes place in Week 8. This section summarizes an approach, on how the risks can be scored to make them comparable.

Step 1 – Synthesis of information on risk characteristics that was gathered through literature review, data analysis and interviews should provide a comprehensive understanding of the AVC's risk landscape. Risks can be compiled in a Spreadsheet (see **Annex E**) where each risk is listed, and data is entered on the risk's frequency, impact per AVC actor group, along with calculations of probability, magnitude, average loss, and maximum loss. For each risk that an AVC actor is exposed to, a quantitative estimate of its impact on the group of AVC actors is provided. If no quantitative estimate is available, an estimate should be used based on a description of the impact.

Step 2 – Defining the risk scoring framework involves the client and relevant experts or stakeholders. It can take place earlier in the work plan (e.g., as part of workshop 1 as suggested in Annex A). Table 2.2 gives an example of criteria that might be developed for sample impacts and how they are scored. This reduces subjectivity and structure discussions, without considering or analyzing correlations. Table 2.3 shows an additional step, the probability score, the chance that a risk event will occur.

Table 2.2. Sample categories for setting an impact score.

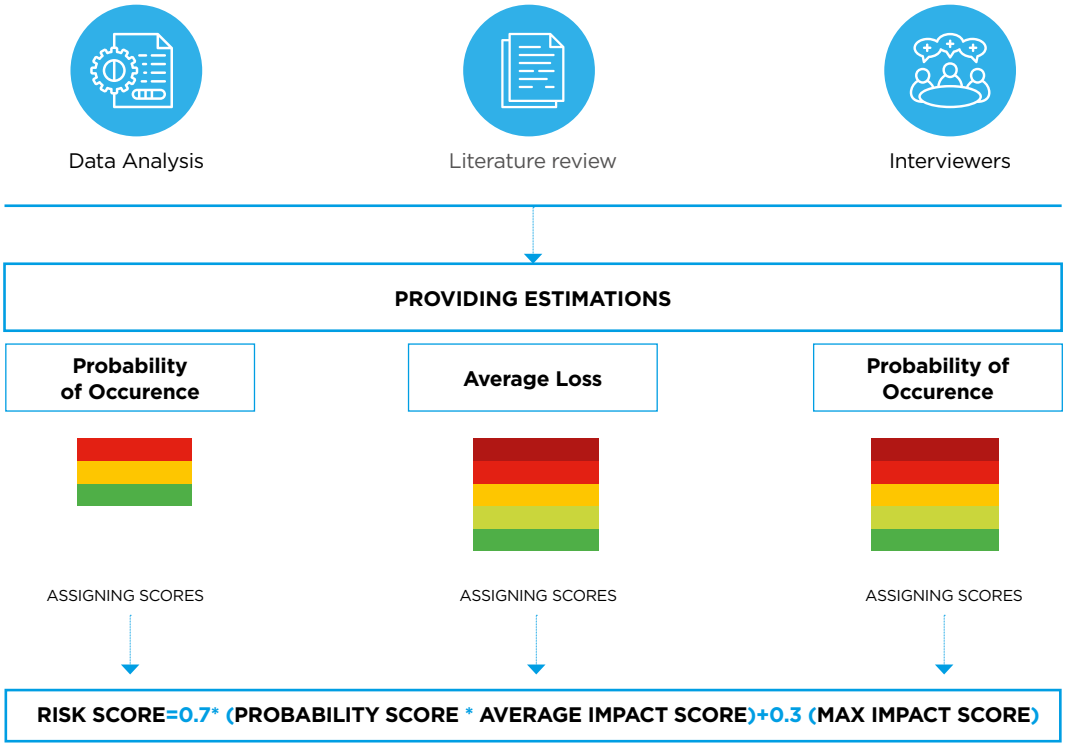
Category of impact	Criteria (example criteria)	Score
Catastrophic	• more than 50% reduction in AVC production or income (World Bank, 2016) • significant income losses impacting 50% or more of the AVC actors • significant impacts felt by at least 90% of women or young farmers • temporary or permanent shutdown of parts or all value chain	5
Critical	• 30-50% reduction in AVC production or income • significant income losses impacting 30% or more of AVC • significant impacts felt by at least 70% of women or young farmers • severe disruptions of the value chain	4
Considerable	• 15-30% reduction in AVC production or income • significant income losses impacting 20-30% of AVC actors • significant impacts felt by at least 50% of women or young farmers • short-term disruptions of the value chain	3
Moderate	• 5-15% reduction in AVC production or income • significant income losses impacting 10-20% of AVC actors • significant impacts felt by at least 30% of women or young farmers • deviations in key parameters including costs, demand, and logistics	2
Negligible	• 0-5% reduction in AVC production • significant income losses impacting less than 10% of AVC actors • significant impacts felt by less than 30% of women or young farmers • minor deviations in key parameters such as costs, demand, and logistics	1

Table 2.3. Example of categories for setting a probability score.

Category of impact	Criteria (from World Bank, 2016)	Score
Highly probable	E.g., this event is likely to occur every 3-7 years. (14% to 33%)	3
Probable	E.g., this event is likely to occur every 7-15 years. (7%-14%)	2
Occasional	E.g., this event is likely to occur every 15-40 years. (3%-7%)	1

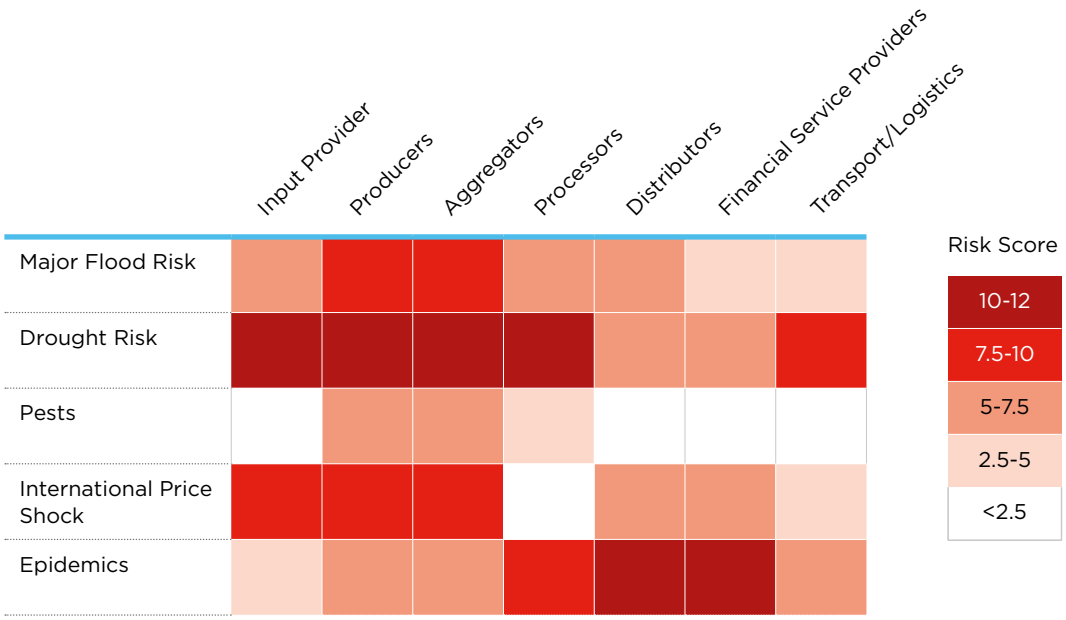
Step 3 – Calculating the total risk score happens through a process that yields risk scores from 1 to 12 for each risk and AVC or AVC actor group. This risk scoring process is shown in Figure 2.6, where the inputs to the process are data analysis, literature reviews, and interviews. Results of these inputs are estimates of frequency of occurrence, average loss and maximum loss. Based on these results, impact and probability scores are assigned. With those scores, a risk score can be calculated by applying the formula presented in Figure 3.6. The risk score is based on the probability score, the average impact score, and the maximum impact score assigned to each risk. The weight of 0.3 gives the maximum loss a relevance in the overall risk score, ensuring that risks that can have devastating effects are appropriately taken into account. This weight is a proposition that can be changed by the Assessment Team.

Figure 2.6. Risk scoring process.



Calculating the risk scores for each risk per AVC actor group leads to a matrix of risk scores that can be presented in a heat map (Figure 2.7). Risk scores enable risks to be compared and prioritized. In the heat map below, the darker the color the higher the risk score. In the example below, the highest (worst) scores are the dark red colored cells for drought that affects input providers, producers, aggregators, and processors, as well as epidemics that affect distributors and financial service providers. These visual displays present a lot of complex data in a way that is easy for people to understand and is useful for comparisons.

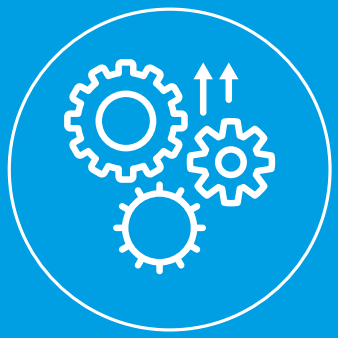
Figure 2.7. Sample heat map of risk scores along the AVC (values for illustration only).



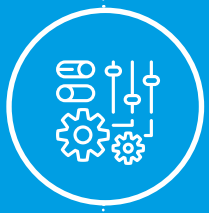
RISK SCORING IN DETAIL
Find it: Annex D.3 provides guidance on each of the steps presented which lead to the risk scores.

Phase 3

Vulnerability assessment



Inventory of AMR solutions



Assessing capacity to manage risks

Calculating a vulnerability index

Phase 3
Vulnerability assessment

The steps in the vulnerability assessment lead to calculating a vulnerability index (VI). The vulnerability of value chain actors or an entire AVC needs to be assessed to develop a targeted and effective agricultural risk management (ARM) strategy. Vulnerability can be measured by an AVC actor group's exposure to and its capacity to manage risk (CMR). The exposure to risks was analyzed in the previous chapter 2 and led to a risk score for each AVC actor group and each AVC. The starting point to gain information about the AVC actor groups' CMR is creating an inventory of existing ARM tools and policies and discussing local communities and gender-related vulnerabilities. Part of this step is assessing the vulnerability of special target groups: women, youth, refugee or landless populations, etc. These groups often have much higher vulnerability, and may be especially important within one point, e.g., production or processing, of a value chain. The next step is measuring each AVC actor groups' CMR. Finally, a vulnerability index is calculated, which combines the risk score (described in section 2.3) and the CMR score. The vulnerability assessment should be applied with the same units of analysis/ AVC actor groups as the risk assessments. A different assessment is done for each AVC if more than one AVC is selected. Sometimes, sub-groups within defined AVC actor groups may have differences in how vulnerable they are, e.g., due to gender or location, so these AVC actor sub-groups should be split into separate analysis when feasible.

3.1. Inventor of Agricultural Risk Management solutions

The goal of this inventory is to list existing ARM tools and policies and assess their effectiveness, which is done by analyzing literature and reports, interviews with experts and AVC actors. This typically takes place in Weeks 2-7. To assess the CMR, it is crucial to first get an overview of risk management solutions that are currently in use or planned. Such solutions can include local or regional strategies supported by public or private agents, led by households or communities; market tools to transfer risk; or government policies, strategies, or interventions. In addition to the assessing regular AVC actors, it is vital to assess the vulnerability of specific groups that may be important to the value chain; looking at gender is a starting point, but there may also be other vulnerable groups.

Risk management measures are activities to address an identified risk and can be divided into three categories: risk mitigation, risk transfer, and risk coping. **Risk mitigation** refers to measures that reduce the likelihood and/or severity of a potential future risk event. There are many options for risk mitigation, and they often target high frequency risks. For risks that cannot be mitigated, **transferring** the risk to a third party is an option, which is what insurance does. With insurance as an example, a risk is transferred to an insurer, who pays compensation payment for losses if the risk event occurs. The third category,

risk coping mechanisms, are measures that help actors better recover from events (World Bank, 2016). Table 3.1 provides an overview of these categories with examples of tools (World Bank, 2005).

Table 3.1. Selected risk management measures in agriculture.

Informal mechanisms	**Formal mechanisms**	
	Market-based	**Publicly provided**
Mitigation		
Soil drainage, mulching, conservation farming, stress-resistant varieties, irrigation, diversification of crops or income sources, storage, etc.		Agricultural extension, pest management system, infrastructure (roads, dams, irrigation), market information systems, trade policies, etc
Transfer		
Informal risk pool, crop sharing	Insurance, hedging, contract farming and marketing, future contracts	Public insurance
Coping		
Borrowing from relatives, selling livestock or property	Savings, loans	Social safety net programs, cash transfer

Source: World Bank 2005

Risk management measures can be taken by single actors or multiple stakeholders. For example, single actors can apply agricultural practices, buy insurance, or use a trading or hedging strategy. Sharing market information to manage price risks and improving contractual relationships to manage counterparty risks, are activities that require collaboration between two or more parties. ARM tools or policies can be implemented on micro, meso, or macro levels, making it important to consider all levels for assessing current risk management measures (World Bank, 2016).

Step 1 – Identifying existing ARM tools and policies is done for the risks that were identified in previous steps, including information about existing and planned ex-ante and ex-post risk management strategies at various levels, for mild, medium, and catastrophic events. A key question is: "What prevention, reduction, mitigation, transfer, or sharing options do actors along the AVC have?" This question should be posed separately for each AVC actor, including for gender-differentiated actor groups to ensure that gender-specific availability of ARM tools is registered. For this step, information sources include a) interviews with key informants and actors; b) relevant government policies, development programs and projects; c) market instruments and community devices, reports about the business environment and

markets, and practices related to the insurance market, banking sector, logistics, etc.; d) publications about risk management strategies in the AVC.

Step 2 – Assessing existing ARM tools and policies for their effectiveness and benefits is needed as a second step. If the list of ARM tools and policies is very long, provide a full list of tools and policies, but select the tools and policies with the highest relevance to the value chain, the largest scope or financial size, the greatest potential to address main risks, or the foremost innovative potential. Each ARM measure, whether it is applied by AVC actors or other private and public players, will be evaluated relative to its effectiveness to reduce a risk's impact on the AVC actor group. This assessment is mainly based on statements from interviewed AVC actors and AVC generalists. Assessments of each tool should have a description of the solution including a) ownership, for instance public, private, or cooperative; b) beneficiaries and coverage; c) information about the risk and hazard addressed; d) time frame; e) limitations and weaknesses; f) costs and benefits; g) effectiveness and performance regarding the solution's effect on the AVC actor group's capacity to manage risks. For assessing effectiveness, either available data or reports can be used, or a qualitative assessment by the interviewed AVC actor will be necessary. For rating the effectiveness of ARM solutions, the approach described in section 3.3 below can be applied.

SOURCES FOR INVENTORY OF EXISTING AGRICULTURAL RISK MANAGEMENT TOOLS AND POLICIES

Find it: For relevant literature and information sources see **Annex B.2**.

3.2. Double vulnerability – assessing vulnerability of women and other vulnerable groups

The goal of this section is explaining why and how to integrate gender differences, and challenges facing other specific groups (youth, landless, refugees) into the vulnerability assessment process. This is done by analyzing literature and reports, updating indicators, and interviewing experts and AVC actors in Weeks 2-7. In many AVCs, there are groups that may be "doubly vulnerable" because of other challenges they face. Women in particular face special challenges in agriculture, requiring a special focus on gender within value chains (Box 3.1).

Box 3.1. Women in Agriculture: Exposing Double Vulnerability.

Women are often more exposed and vulnerable to shocks than men due to gender-based discrimination and based constraints that lower women's capacity to manage risks (PARM, 2019b; World Bank, 2017): Women have:

- **lower and fewer assets than men**: with lower land ownership, less fertile, arable land; more difficulties with collateral registries and documents.
- **reduced access to financial services and technologies** and diminished capacity to prepare for or react to risk events.
- **less decision-making power over land and assets**, and lower land ownerships increases women's vulnerability to risk events (Bouchama et al., 2018).
- **20-30% lower agricultural yields than men** even when growing the same crops, given lack of access to information, high-quality inputs, and equipment. This disparity is due to the factors above, e.g., access to financial services and a lack of capital.
- less access to storage facilities, marketing, labor, and transport infrastructure.
- **barriers to information** because of culture, lower literacy, and language, lower levels of skills and knowledge, and inferior access to extension services, agro-technology, or other information providers.
- **less power and decision-making capacity** due to constrained participation in, representation or along the AVC.
- **enabling environments discriminate against** women in many countries through unequal laws and policies or law enforcement.

Yet there can be other vulnerable groups that may be involved for one or more stages of a value chain: youth may be involved in production or on-farm processing or refugees may provide a cheap labor source. While this section justifies the need to look at gender specifically, the process and questions equally apply to other vulnerable populations. Consulting with AVC actor groups in the interview process will likely bring out these vulnerable groups, and special attention to them should be given in assessing their capacity to manage risks and through developing a separate vulnerability index for them.

Consider these and other constraints when choosing the indicators to measure actor groups' CMR across the AVC. Depending on a country's cultural context, other indicators might be relevant to capture gender-related differences. Analyzing men's and women's (or other vulnerable groups) vulnerability separately in subsequent steps will enable analysis and comparison of the differences in their vulnerabilities and better risk management. Recent analytical frameworks propose shifting towards more gender-focused approaches to agricultural risk management (PARM, 2019b; World Bank, 2017). They include suggestions about how to map gender-based constraints along the value chain while pointing out the key challenge of data availability. They also provide guidance on how to collect relevant data and examples of existing useful databases.

Interviews with AVC experts and actors can provide information on gender-differentiated vulnerabilities, and serve as a template for questions for other vulnerable groups (World Bank, 2017):

- **Who is involved** in the value chain being analyzed: for instance, which different stakeholders, segments of the population, and gender roles?
- **What risks** have the greatest impact on women?
- Is there, and what is, **the different exposure and impact of risks** for women and men? Are there regional differences?
- What are women's **current risk management practices** for risk mitigation, risk transfer, and/or risk coping strategies?
- How do women and men manage risks? Are their instruments effective? Why or why not?
- Are there differences or limitations in risk management practices for men or women?
- For different genders, are there some risks that they aren't managing?
- Do supporting institutions have the capacity to manage key risks women mainly face?

DOUBLE VULNERABILITY AND GENDER IN DETAIL

Find it:

- **Annex B.3** lists references to literature regarding gender-differentiated agricultural risk management tools and policies.
- A selection of relevant datasets for measuring gender constraints that can be an indicator for increased vulnerability can be found in **Annex B.7**;
- **Annex E.2** contains a checklist on Gender and Risk

3.3. Assessing Capacity to Manage Risk (CMR)

The goal of this section is to assign a score to each AVC actor group and to each entire AVC for their capacity to manage risk (CMR). This is done on the basis of the inventory from section 3.1, key informant interviews, and calculations by the AT, and occurs during Weeks 2-7.

Risk management is a process that involves identifying, analyzing, and properly addressing risks. **The risk manager needs to be aware of the risk, understand it, and have the tools and knowledge to address it**. Risks are constantly changing and can affect an AVC actor's business in multiple ways. Each risk can require a different set of capacities, such as specific abilities, skills, understandings, attitudes, and values; social relationships, behaviors, motivations, resources, and conditions; and instruments, information, or technologies (Bolger, 2000). This toolkit proposes a rapid approach for learning from each actor group about its capacities for risk management. Depending on the context, scope, and selected AVC, information about the actor groups' capacities can sometimes be found in literature or datasets. In the proposed approach, interviews with key informants and actor groups are considered the most important sources of information, being aware that they can only provide information about the actors' perceived capacity to handle risks. Independent indicators to measure the actors' CMR would be needed for a more objective, but also more extensive approach, similar to the method suggested in the Climate Risk Vulnerability Assessment (Box 3.2).

Box 3.2. Climate Risk Vulnerability Assessment.

For studies that go beyond a rapid assessment, a more extensive approach can be applied. In the Landscape Climate Risk Vulnerability Assessment (CRVA) study in Isabela, Philippines (Palao et al. 2019), the municipalities' capacity to adapt to climate change is analyzed by measuring a set of indicators. These indicators are collected from online and local databases composed of socioeconomic and biophysical data, and interviews with AVC actors. There are three clusters of indicators: satisfaction of basic needs, capacity for innovation, and capacity for action. A long list of indicators measures which aspects of capacity a municipality has, covering these categories of capital: natural, social, human, political, cultural, physical, and financial. An example of a list of indicators is provided in Annex B.8. This type of analysis is too extensive for the scope of an AVC-RAS.

Small-scale operators – such as farmers, processors, traders, and sellers – and women are less well-integrated into the value chain and suffer from disadvantages (Mrdalj & El Bilali, 2019). Performing a thorough literature review will shed light on patterns of vulnerability and capacity and identify if groups of AVC actors need to be split into sub-groups -- for example, of doubly vulnerable groups (Section 3.2, above) to separately analyze their CMR. This is particularly important if the client's objective is to increase the resilience of vulnerable groups. If the AVC actor group is not divided into sub-groups, then there is no need to identify sub-group exposure or specific ARM solutions later.

The interview process helps identify two types of ratings for AVC groups or sub-groups, for each option and interviewee:

- **Effectiveness rating (ER)** of options to manage risks.
- **Accessibility or applicability rating (AR)**, rating the capacity to access or apply options.

The starting point of the CMR calculation is the inventory of section 4.1. The AT learns from interviews with AVC actors about their access to ARM options and complements the inventory of options. Furthermore, the AT asks interviewees about their perceptions of the options' effectiveness. This leads to a list of options with ratings of ER and AR, similar to the example presented for drought risk in Table 3.2. A multiplication of the ER and AR values leads to the CMR Option Score. The AT then calculates the average of the CMR Option Scores to derive the Drought risk CMR Score. If several representatives of an AVC actor group are interviewed, the AT needs to calculate the average of the scores to derive one value per risk and AVC actor group. The scores can also be calculated for different sub-groups, for example, women. In order to define a risk score for an entire AVC, either the average of all actor groups' CMR scores is computed, or the weighted average is calculated using the number of people involved in an AVC actor group as the weight reference.

Table 3.2. CMR rating table with numerical examples for drought risk.

Drought	Option	Effectiveness Rating (ER), scale 1-3	Accessibility/ Applicability Rating (AR), scale 1-4	CMR Option Score = ER*AR
Mitigation	Irrigation	3	3	9
Mitigation	Investing in varieties	2	2	4
Transfer	Insurance	3	3	9
Coping	Savings	3	4	12
Coping	Family	2	4	8
Coping	Government	1	3	3
Drought Risk CMR Score (Average)				7.5

Ideally, the AT could learn more about the AVC actor group's behavior and willingness to learn and apply new technologies or solutions. However, this information would have to be gathered through a bigger survey to gain a picture of the behavioral patterns of an entire AVC actor group, because this information is very personal and can vary a lot from individual to individual and from firm to firm. Such a survey is not in scope of this toolkit but could be developed if more time or resources were available.

CAPACITY TO MANAGE RISKS (CMR) IN DETAIL

Find it: The detailed interview process is in **Annex E.1** with references to **Annex I** and guides the field work on CMR and practical calculation of CMR scores.

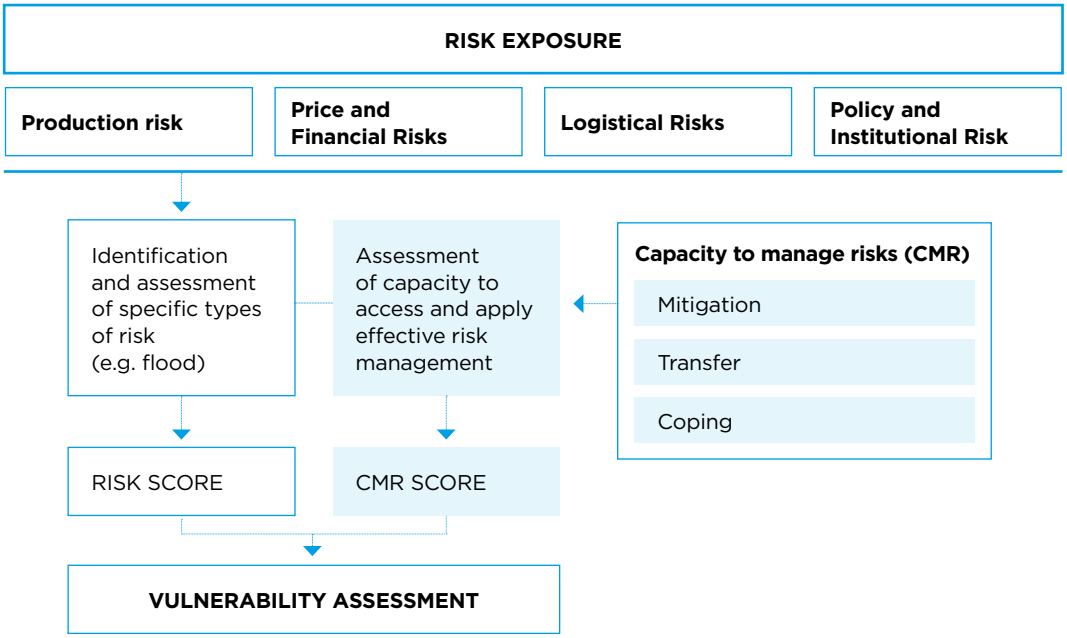
3.4. Calculating a vulnerability index

The objective of the work discussed in prior sections, is to calculate a vulnerability index for each AVC actor group and each AVC. The AT does this, typically in Week 8, by making calculations with the information derived in the previous sections of chapters 2 and 3. The two key dimensions of measuring vulnerability in the value chain are:

- **Exposure** - the nature or degree of a value chain's exposure to significant risks, which is measured with a **risk score**.
- **CMR** - the ability of a value chain's actors to manage identified risk events, meaning the capacity of existing measures for avoiding, reducing, mitigating, or transferring or sharing risks, or the capacity to cope with risk consequences by accepting and preparing for them.

A vulnerability index is calculated from the risk score and the CMR score using the framework presented below. The result of the vulnerability assessment is a vulnerability index for each AVC and AVC actor group and risk event that enables direct comparability for prioritizing, as shown in Figure 3.1.

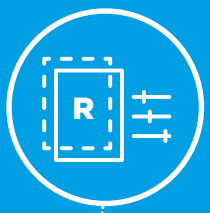
Figure 3.1. Vulnerability index.



CALCULATING A VULNERABILITY INDEX IN DETAIL
Find it: The practical steps of calculating the vulnerability index can be found in **Annex E.1** with references to **Annex I**.

Phase 4

Risk mapping and prioritizing



Risk mapping

Prioritizing risks

PRIORITIZING RISK
WORKSHOP 2

Phase 4
Risk mapping and prioritizing

Mapping and prioritizing risks, and a prioritizing workshop, are the next steps that follow the calculation of the Vulnerability Index and take place in week 9. These are important steps because they are used to evaluate the quality of the Vulnerability Index by looking at the results from different perspectives and comparing selected AVCs, risks, and AVC actors, and combinations of these. To complete this evaluation, the AT maps the scores using visualization tools described in the risk mapping section below. These visualizations and potential outcomes are used as the basis for a prioritization workshop. Relevant stakeholders are invited to the prioritization workshop. The workshop produces a short list of prioritized risks that need to be addressed with risk management solutions.

4.1. Risk mapping

The goal of risk mapping is to provide supportive graphs, tables, and illustrations for the risk prioritization. These are based on the AT's judgment and ability to display information and takes place in Week 9. Mapping identified risks and vulnerabilities is an important step in the AVC-RAS and involves synthesizing the calculations, estimations, and scores from the Vulnerability Index into summaries and visualizations that can be compared and interpreted. This chapter provides a few examples of developing tables and infographics that are easy to interpret by relevant stakeholders and that easily convey results for different audiences. The AT should discuss the choice of graphics, document the reasons for its decisions, and then prepare a storyline that describes what led to the short list of risks and actors, supported by graphics.

The scores assigned to each risk in the previous sections respond to the objectives of the AVC-RAS, so they serve as the main criteria for risk prioritization. Visualizing both risk and vulnerability scores provides an important input to the risk prioritization workshop. The vulnerability index is a result of risk and CMR scores (Table 4.1). The risk score is composed of the scores "probability", "avg. impact", and "max. impact" whereas the CMR score is composed of CMR scores for each ARM option. The hierarchy presented in Table 5.1 should help to structure the visualizations of these scores and visualize the scoring levels that are the most useful to the prioritization.

Table 4.1. Levels of scorings.

Scoring Level 3	Scoring Level 2	Scoring Level 1
Vulnerability Index	Risk Score	Probability Score
		Avg. Impact Score
		Max. Impact Score
	CMR Score	CMR Score per ARM option

The next step is for the AT to answer a set of questions that can help prioritize risks. These questions help guide the AT to have an overview of the risk analysis results, the results of the capacities to manage risks analysis, and the vulnerability indices (which combines risk and CMR scores). Based on this overview, a selection of risks or AVC actor groups should be made for each AVC for which further details are needed. The following suggestions provide some examples for discussion, recognizing that the AT may add or delete questions as appropriate.

Risks Identified

1. What is the risk profile of an entire AVC or a particular AVC actor group? Which risks is the AVC exposed to and what is its capacity to manage them?
2. Which AVC actor groups are affected by a particular risk and what is their capacity to handle it?
3. What is the annual average loss associated with each risk for each AVC?

Actors' Capacity to Manage Risks

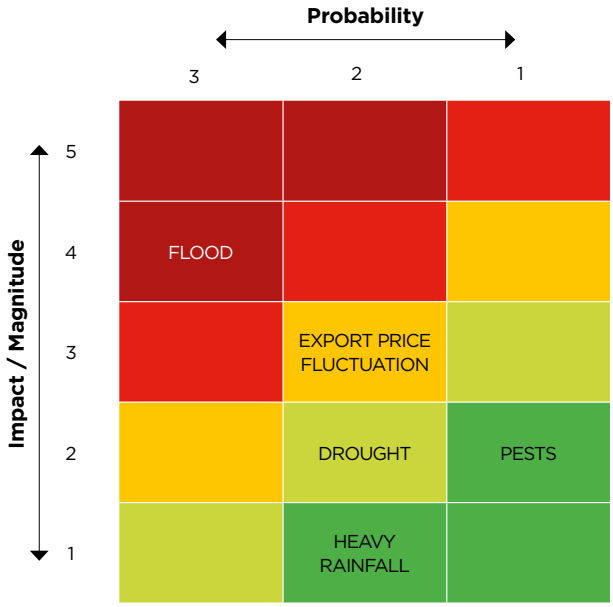
4. Which risks do AVC actors have the lowest capacity to manage?
5. Which AVC actors have access to effective ARM tools to manage a particular risk, and which show a gap?

Vulnerability indices

6. Which AVCs show the highest vulnerability indices, and for which risks?
7. Which AVC actors are the most vulnerable to which risks in the selected AVC(s)?

The following illustrations give some examples of different ways to display data. The justification and further examples are in **Annex F**.

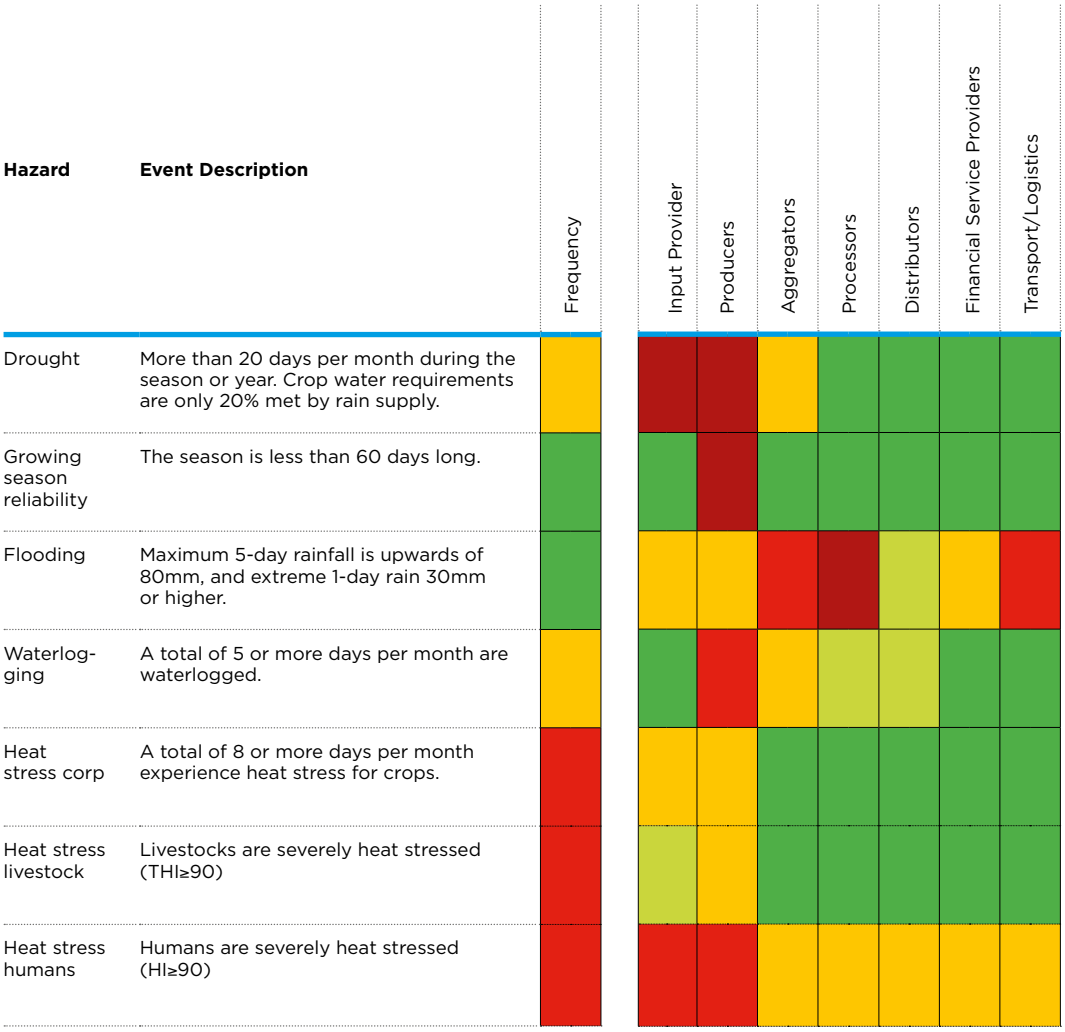
Figure 4.1. Example of a Risk Matrix.



A risk matrix (Figure 4.1) can be used for each AVC actor group or for a whole value chain. These matrices provide visual support to compare different risks, and priorities are evident by looking at the grid, where the highest impact and highest probability of a risk occurring is marked in darker red colors. Risks in the red and orange cells could be designated as priorities.

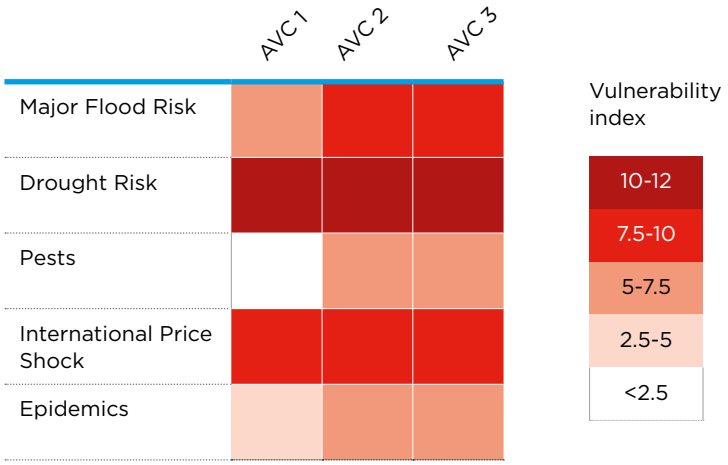
A heat map can make it easier to compare the values of impact and probability across AVC actor groups. Figure 4.2 shows the probability and impact scores taken from the assessment results in a matrix. For each AVC actor group, the heat map shows the scores for selected examples of weather risks based on impact and on frequency as a substitute for probability (from the sheet entitled "Scores" in Annex I). It is easy to quickly see that heat stress is the most frequent hazard, but it only seriously (in red) affects input suppliers and producers. In contrast, flooding has a low frequency, but it impacts 3 different AVC groups badly (dark red and red) and another 3 moderately (orange). Heat maps provide a direct way to visualize both intensity and trade-offs.

Figure 4.2. Heat Map of an example of scored weather-related risks for a given AVC.



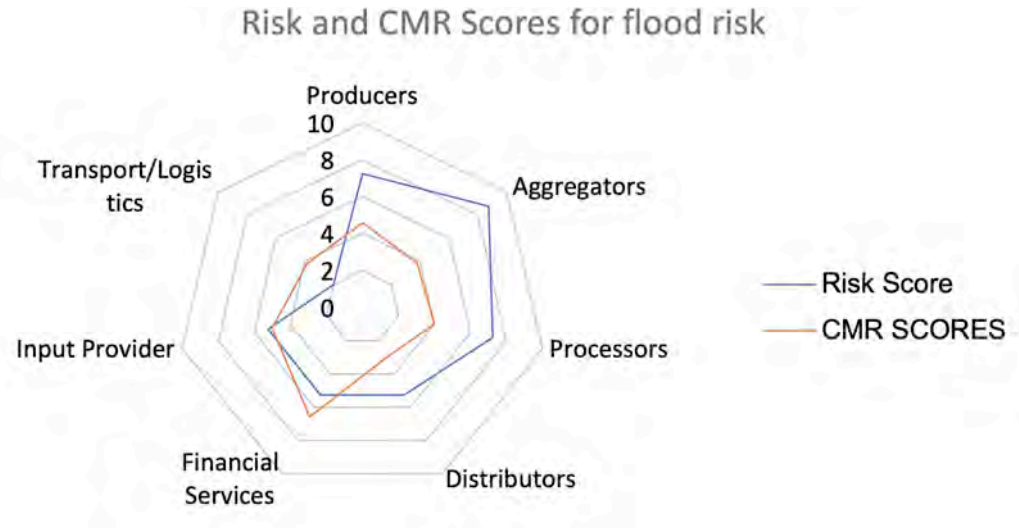
Heat maps can also be designed to compare risks across value chains, with a separate heat map for each AVC and risk. Based on this visualization, the top risks to each AVC can be prioritized. Different metrics can be used in designing the heat map. For example, to compare how vulnerable each of the AVC's below are, it is possible to weight the vulnerability index based on the monetary value of each AVC and draw a heat map. This integrates monetary losses from different risks into the heat map. In Figure 5.3 below, it is clear that drought risk causes the greatest economic losses to all three value chains. Overall, AVC 1 has the lowest vulnerability index, while AVC 2 and 3 have identical vulnerabilities.

Figure 4.3. Comparison of vulnerability indices across agricultural value chains.



Spider graphs are another way of providing information. The example in Figure 4.4 shows how a particular risk affects the actors of an AVC, since the risk score and the CMR score can be compared. This visual display shows that the risk exposure is high for producers and processors, and to a certain extent for distributors, financial services, and input providers while apart from financial service and input providers, all actors show a rather low capacity to manage flood risk. A spider graph is another way to visually represent the same type of information that is in the 3 graphics above.

Figure 4.4. Example of a spider graph for risk and capacity to manage risk scores.



RISK MAPPING IN DETAIL
Find it: **Annex F** provides examples and guidance on best ways to illustrate each of the questions.

4.2. Prioritizing risks

The goal is to prioritize a short list of risks, based on the AT's preparation and judgment, and a stakeholder workshop. This typically happens in Week 9. After visualizing the identified risks for all relevant AVC actors and all AVCs, the risks are prioritized, providing a short list of risks. It is time to engage the stakeholders that will be implementing the risk management strategy and the final action plan. For this, the AT organizes a stakeholder workshop 2 (**Annex A**) to review and prioritize the analyzed risks. In preparation, the AT will generate visualizations of the risk assessment results (section 4.1 and **Annex F**) and suggest a first shot at the risk prioritization. The methodological results presented at the workshop serve as the basis for discussion of priorities by stakeholders. Priority-setting involves some degree of subjective judgment by stakeholders and decision-makers based on the quantitative process presented to them by the AT, since it involves their personal judgments and potentially their vested interests. By incorporating the results from the risk and vulnerability assessment and following suggested steps, **the AT can make the prioritizing process as objective, transparent, and traceable** as possible. All components of decision-making should be documented and explained. The following prioritizing process should be adapted based on the particular objectives and client interests of the AVC-RAS.

The vulnerability index is the relevant variable that integrates assessment of risk and the capacity to manage risks. We recommend the following steps to identify the most important risks and actor groups for developing the action plan:

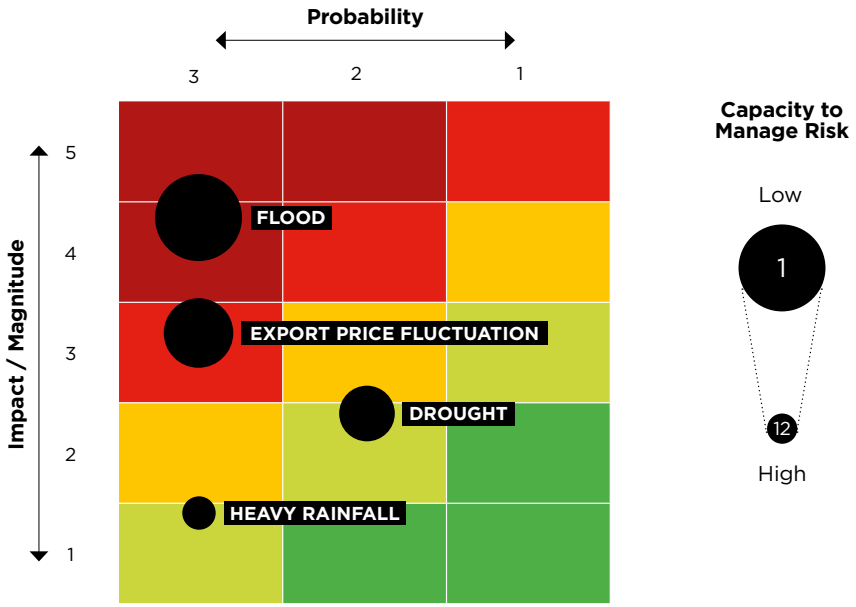
1) Ranking of risks

2) Ranking of vulnerable actor groups

The first step, ranking the risks, starts with a comparison of the selected AVC's vulnerability indices. Heat maps are a useful instrument, with the style used in Figure 4.3 to visualize the AVCs' different scores. With this, the AT can select the most pressing risk for each AVC. Weighting is useful to compare across AVCs and can be done by applying a weight representing the AVC's production value to the vulnerability index (VI). This supports direct comparability of the VIs of different AVCs and allow for prioritizing risks across the whole set of AVCs. However, this step won't be required in most cases, and prioritizing risks for each AVC is sufficient to meet the client's needs.

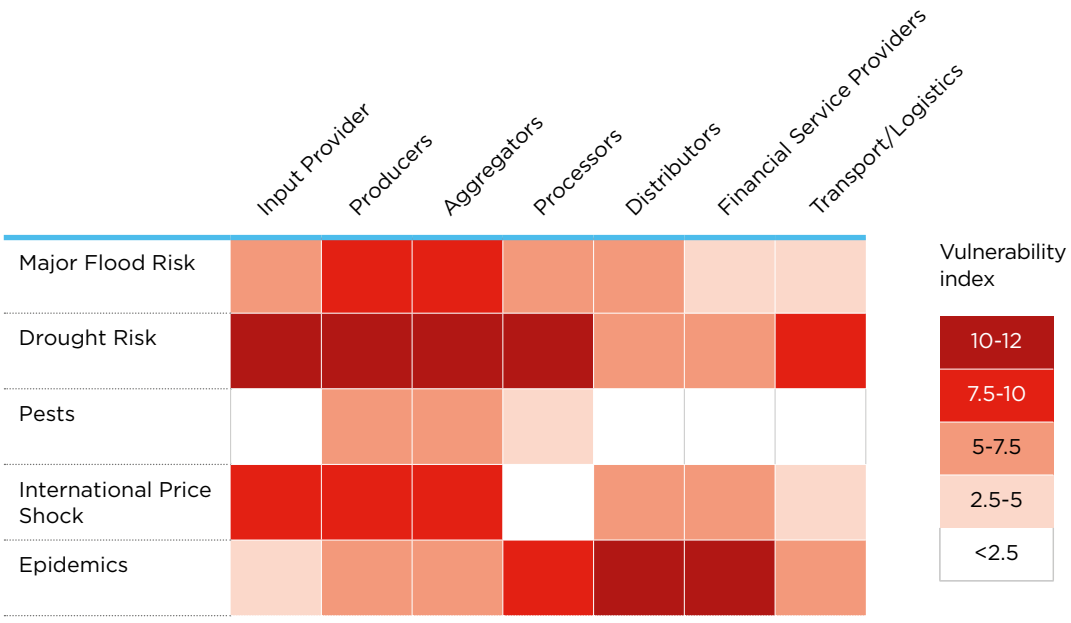
To validate the selected short list of risks, we also recommend analyzing the risk matrix for each AVC, including information about the CMR (Figure 4.5). Based on the resulting matrix, the AT composes a second short list of prioritized risks. As a validation, the two short lists are compared, and the AT synthesizes a final short list.

Figure 4.5. Sample risk matrix for risk prioritizing.



The second step enables identifying the most vulnerable actor groups by producing a heat map for each AVC, showing the short list of risks and the VI for each actor group (Figure 4.6). Based on the VI values, the AT can identify which actor groups are most vulnerable to these risks and make a short list of actors to address in the action plan.

Figure 4.6. Sample heat map for prioritizing by actor groups.



A stakeholder workshop (Workshop 2) is then held to reassess the ranking and agreed upon a final short list of risks and actors to consider in developing an action plan. We suggest planning a whole day for this workshop, or two half-day blocks if it takes place virtually, to allow time for discussion and the resolution of any disagreements. The results of the AT's prioritizing exercise should be shared with participants beforehand. According to the work plan (chapter 1), Workshops 2 and 3 are intended to be conducted one week apart from each other. This allows for a proper preparation of workshop 3 (section 5.2 and Annex A). However, it would be possible to merge these two workshops and conduct them in one event. In that case, a second, day-long workshop would follow immediately upon this prioritizing exercise. The objective of Workshop 3 is to define a short list of ARM solutions for developing an ARM strategy based on the risks identified (Section 5.2 and **Annex A**). Both workshops are expected to take 1 day and could be held together in a 2-day workshop.

RISK PRIORITIZATION IN DETAIL
Find it:

- **Annex A** provides detailed information and guidance on Workshop 2 above, and Workshop 3 which is mentioned above, and briefly described below.
- **Annex G** gives guidance regarding the write-up for the final report.

Phase 5

Agricultural Risk Management solutions

Gap analysis

ARM SOLUTIONS
WORKSHOP 3

Develop action plan

VALIDATE ACTION PLAN
WORKSHOP 4

Phase 5
Agricultural Risk Management solutions

The AVC-RAS develops an action plan that leads to improved risk management in the selected AVC(s). This chapter suggests a participatory approach for developing a risk management strategy. This approach assumes close involvement of the steering panel and other important stakeholders, including but not limited to, government representatives, experts, key private-sector actors such as representatives from agro-industry, financial service providers, and producer associations, and relevant projects, programs, and NGOs. The AT adapts the methodology to fit local circumstances and political processes. The final product, the action plan, should be validated and owned by the relevant decision-makers.

5.1. Gap analysis

The goal of the gap analysis is identifying appropriate risk management strategies/treatments for identified risks based on the AT's preparation and judgment and a stakeholder workshop. The timing occurs in week 10. After the risks and vulnerabilities along the AVC are assessed and the risks are prioritized, the next step is developing a tailored risk management strategy. To this end, evaluating the prioritized risks and AVC actor groups is a necessary first step to identify gaps in available ARM instruments. The second step is composing a long list of potential risk management instruments with mitigation strategies, transfer instruments, and coping mechanisms to address those gaps. The third step, selecting optimal ARM solutions, requires balancing multiple trade-offs, including: the estimated costs and benefits of a specific measure; how practical and long implementation is; and scalability and coherence with other instruments and policies. Analyzing these trade-offs and selecting optimal ARM solutions does not result from a strict quantitative process, but rather from solid discussions on the advantages and disadvantages of different pathways. Risks can often be addressed by several measures and combining multiple strategies may be a strong solution. Ideally, the solutions should comprise a package of risk management strategies, measures, and tools that addresses the prioritized risks. Three steps outlined below guide the AT through evaluating risks and proposing ARM strategies, measures, and tools.

Step 1 – Evaluating risks and available information helps the AT identifying gaps in the current risk management options. For each prioritized risk, the AT evaluates available information on risk criteria for the entire AVC and for AVC actor groups. This should be a broad evaluation that considers: the assessed probability, average loss, average annual loss, maximum loss, vulnerability, causes of risk, the AVC's context, public- and private-sector services to the value chain, existing ARM tools, policies, programs, and other factors. Spider graphs and heat maps can help pinpoint gaps in the current risk management options. The AT can use these visualizations for different risks to compare the effectiveness rating for

ARM tools by each AVC actor group or to display other information gleaned from interviews with actor groups. Analyzing the interview results provides detailed information about the needs of AVC actor groups to manage their main risks. The AT evaluates and summarizes the situation analysis for each prioritized risk and highlights gaps in the current risk landscape, which might lead to the following decisions regarding required actions:

- some risks need further analysis,
- some risks can be addressed with existing measures,
- existing measures are not effective and need to be redesigned, or
- additional risk management solutions are needed to reduce the risk (ISO, 2009b).

These decisions are guided by the client's objectives. If, for example, the client's objective is increasing the resilience of specific vulnerable groups, the AT must identify gaps and constraints associated with current ARM tools that make them ineffective in addressing the risk exposures of vulnerable groups.

The assessment team could compose a table similar to Table 5.1 listing prioritized risks, and for each risk filling in information about corresponding existing ARM solutions, information about existing solutions' effectiveness and actors' access, gaps in the current ARM solutions, and suggestions of required actions to address the gap. The information filled into this table is a synthesis of information collected through literature review and interviews, and the AT's own judgment.

Table 5.1. Template for a gap analysis.

Risk	Scores	Existing ARM solutions	Current effectiveness, expectations for the future	Gap	Required action

EXAMPLE OF A GAP ANALYSIS
Find it: An example of a gap analysis performed for an agricultural-sector risk assessment for Tanzania by the World Bank (Arce & Caballero, 2015).

Step 2 – Creating a long list of potential risk management strategies to address identified gaps again is based on inputs from previous activities. Section 3.1 presents categories and options for risk management tools, such as risk mitigation, risk transfer, and risk coping tools. The following options for risk management strategies suggest categories of strategies for each prioritized risk (ISO, 2009b):

- **avoiding the risk** by not starting or continuing the activity leading to the risk;
- removing the risk source;
- changing the probability of occurrence;
- changing the impact or consequence;
- **sharing the risk** with another party or parties (e.g., through insurance and risk finance);
- **retaining the risk** by informed decision.

Gender inequality and social exclusion adversely impact the effectiveness and sustainability of ARM strategies, so strategies that are gender-specific strategy or that look at other vulnerable groups are often beneficial (PARM, 2019b). Reducing gender inequality is a proven strategy to significantly increase economic resilience (Ferrant and Kolev, 2016; World Bank, 2012). A gender-differentiated approach to AVC analysis accounts for gender differences in risk management behaviors. These differences significantly influence the differentials in vulnerability between social groups that need to be recognized and addressed with management strategies that are tailored to those groups' needs and capabilities.

Risk treatments can introduce secondary or new risks into the process. For example, introducing a more resilient production input, can bring new risks linked to its supply or application. These risks should be considered and addressed with additional risk treatment measures in the same strategy (ISO, 2009b), with a clear understanding of the context of a risk and its treatment to judge the treatment's effectiveness. The long-term effectiveness of certain tools can vary from country to country due to differences in culture, regulations, or the economy. For example, taking a loan can be a valuable coping mechanism to recover from a risk event in one context, but elsewhere it can create a poverty trap due to unfavorable lending conditions. Therefore, a literature review about past experiences of ARM tools in the country and value chains should be done prior to Workshop 3. The AT must be aware of ARM practices that could be harmful to society, the environment, or the economy, through literature reviews and interviews with experts and other key informants. Existing legal and regulatory frameworks, programs, and available budgets should also be considered.

EXAMPLES AND REFERENCES ABOUT ARM STRATEGIES

Find it:

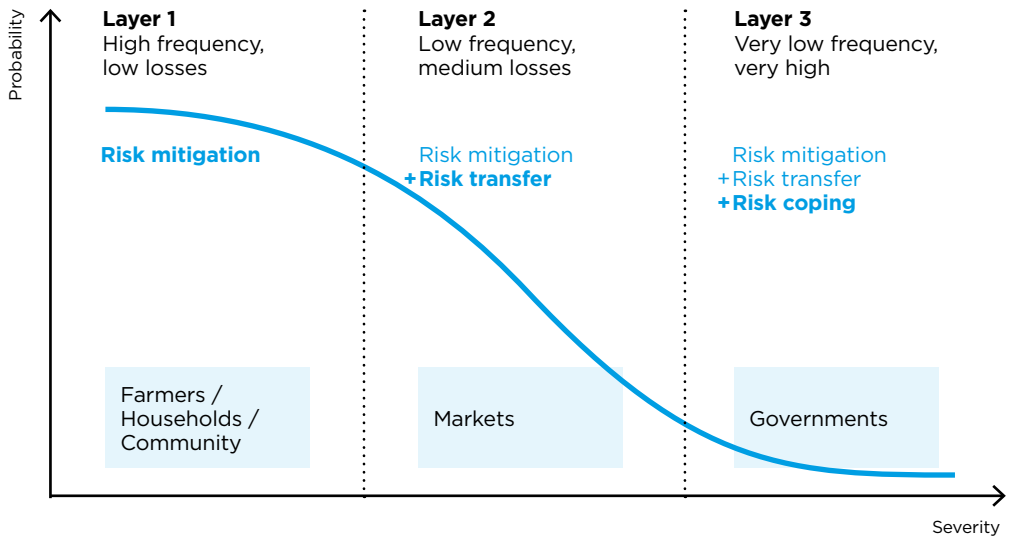
- **Annex D** provides examples of ARM tools and policies.
- **Annex B.4** provides references of relevant literature about tools and policies for the agricultural sector.
- **Annex B.3** listing literature specifically addressing gender-based constraints and risks. Before integrating gender-responsive tools into the long list, it is key to understand the local context and discuss potential negative effects of the implementation of the tools (PARM, 2019b).

Step 3 – Selecting optimal ARM solutions or strategies should consider:

- the characteristics of the risk,
- relevant actors' current CMR, and
- benefits and constraints on the implementation of the strategy (World Bank, 2016).

To consider the **characteristics of the addressed risk** is relevant because no one risk management solution can address all risks under all circumstances. Depending on the risk's characteristics, such as probability and severity, a different set of risk management solutions might have the best potential for sustainable success. Figure 5.1 shows risks with a high probability of occurring but low severity; these can best be treated with risk mitigation measures. Risk transfer is a more suitable solution for hazards with a lower probability but higher severity, and they might be combined with risk mitigation measures. Risks with a very low probability of occurring but catastrophic severity are often treated with a combination of risk mitigation, risk transfer, and risk coping mechanisms.

Figure 5.1. Risk management layers.



Source: PARM 2017, adapted from OECD 2009

Many prioritized risks can be managed by strengthening current risk management measures and strategies. No country or value chain starts from zero, so all the solutions do not have to be new strategies or new tools. The **CMR interviews** with AVC actor groups provide valuable inputs regarding existing ARM options that need some improvements in terms of accessibility or applicability, or effectiveness.

To compare different risk management solutions regarding their **benefits and constraints**, a cost-benefit analysis is ideal, but in most cases, it is not feasible within the scope of this study. Therefore, we recommend performing a rapid assessment on the list of strategies by using a decision filter (World Bank, 2013) based on the following nine criteria (Table 5.2).

Table 5.2. Criteria to assess ARM strategies.

Return time	Relative benefits and effectiveness
Relative costs	Adverse impact on the environment
Scalability	Gender inclusiveness
Ease of implementation	Potential impact on poverty alleviation and food security
Status of implementation: new, partially implemented, existing but room for improvement	

The criteria used for this selection process should be adapted by the AT in order to reflect the objectives and risk variables of the AVC-RAS. For example, some of the decision criteria could be replaced by factors such as "potential impact on food security" or "potential to reduce vulnerability of a specific actor group" if applicable. Following this assessment, the AT proposes a **short list of risk management strategies** to fill identified gaps in the risk landscape, considering the benefits, context, and constraints for implementation. The short list provides a realizable package that can effectively reduce the client's uncertainty with regard to achieving its objectives, which entails lowering the volatility and increasing the resilience of the AVC. The AT will describe the risk management strategies in detail along with concrete instruments required for implementing them. Examples of such instruments typically include agricultural investments, technical assistance, or policy support, independent of the particular AVC actors involved and whether risk mitigation, risk transfer, risk coping, or a combination of those strategies are chosen (World Bank, 2016). As a preparation for the workshop 3, it is helpful to summarize the selected risk management strategies, providing information about the objectives, risk addressed, justification, instruments and activities required, as well as information about how this strategy is embedded into existing programs, strategies and policies.

5.2. Developing action plan

The first step after the gap analysis is to run a workshop at the end of week 10. Stakeholder Workshop 3 decides which ARM solutions to include in the action plan. This workshop identifies a focused list of interventions to develop into an ARM action plan. The key objectives of this workshop are to

- Share and discuss the risk assessment results with a representative of each group of value chain actors;
- Identify a focus list of 4-5 risk management strategies; and
- Gain stakeholders' opinions about additional information to be used in the action plan, such as proposed activities, justification, requirements, beneficiaries, estimated implementation period, implementing institution etc.

Stakeholder representatives can be drawn from the steering panel, government representatives, and experts from the private and development sectors. This workshop could be merged with Workshop 2 on prioritizing risks (Section 4 above and Annex A).

WORKSHOP 3
Find it: A description of objectives, format and activities of each workshop can be found in **Annex A**.

The workshop 3 will provide a collection of opinions and estimations about the following elements of an action plan:

1. characteristics of the risk including probability, average loss, annual average loss, maximum loss, and CMR; suggested risk management measures and beneficiaries; reasons for selecting these measures; expected benefits including gender responsiveness;
2. accountable person(s), institution, or department for approving the plan;
3. accountable person(s), institution, or department for implementing the plan;
4. proposed activities;
5. resources required, including contingencies and suggested funding sources;
6. performance measures and constraints;
7. reporting and monitoring requirements; and
8. timing and schedule.

After the workshop, the AT will have to finalize the action plan in weeks 11 and 12. For this, the AT should also informally discuss the action plan in detail with relevant government agencies, potential implementers, experts in the field of project implementation or proposed risk management interventions and with the client before the Workshop 4, the validation workshop. These discussions should be used to close gaps in information, validate estimations, and ensure that important questions or conflicts are solved before the

workshop. Depending on the local context, a check with the checklist in **Annex E.2** can help to verify if the plan considers gender-related aspects adequately. The AT needs to ensure that estimations and descriptions of proposed plans and figures are realistic and as accurate as possible. An overall action plan should provide a description of the relevance of the selected risk, describing probability of occurrence, impact and vulnerability, an overall objective of the action plan, activities and timing, a justification of the suggested plan, and a general description of requirements and assumptions need to be realized to make the plan feasible. Table 5.3 proposes a list of minimum information that needs to be included in the final action plan.

Table 5.3. Minimum information to include for each risk the action plan addresses.

Risk addressed	Objective of the action plan
Relevance of risk to AVC	Period of implementation
Activities	Justification of plan
Beneficiaries	Resources, requirements, assumptions
Constraints, challenges	Performance indicator
Responsible institution	Success factors

The AT develops based on the information gathered in workshop 3 and following research activities on a feasible action plan that addresses the prioritized risks in harmony with the clients' objectives. It is possible that the AT needs to correct a potential bias of opinions coming from the stakeholder workshops.

A final Workshop 4, validates the AVC-RAS action plan, obtains stakeholder commitments, and celebrates the completion of the AVC-RAS study. This capstone workshop involves decision-makers from the government and relevant agencies, experts, representatives from the AVC, NGOs and others. The AT should make a final presentation that informs stakeholders about the residual risks in the AVC that are not addressed by the action plan, emphasizing that continuous monitoring and reassessment of risks is necessary. The client or the AT shares anticipated steps to implement the action plan and other actions related to the completed risk assessment. The result of the workshop should be an approved action plan with clear accountabilities for these next steps. If possible, the relevant stakeholders will sign a document demonstrating their commitment.

WORKSHOP 4

Find it: A description of objectives, format and activities of each workshop can be found in **Annex A**.

The workshop 4 and finalization of the action plan are the final milestones of the AVC-RAS. In order to complete the study, the AT completes the AVC-RAS report, guided by the Writing Guidelines of **Annex G**.

Results of the AVC Risk Assessment Study

At the end of the 12-week, the AVC-RAS results in two deliverables. The first is the Action Plan, and the second product is the AVC-RAS report. It is crucial to understand that the result of this AVC-RAS is the starting point of an activity.

The Action Plan is a strategic document that belongs to the client of the AVC-RAS. It should guide decisions and investments to improve the selected AVC's risk management. Results will vary depending on country and AVCs under review, and so do processes required for bringing the action plan to implementation status. The Action Plan should provide detailed information about the proposed activities to facilitate the kick-off of the implementation. The first follow-up activities needed are formal decisions to implement the action plan, clarification how the implementation is financed, and a decision about the implementation mode and partners involved.

AVC-RAS report can be published in order to provide a better understanding of the risk landscape of a country's crucial AVCs. The report will provide a valuable source of information to various stakeholders such as governments, investors, NGOs, and to actors in the AVC. It can serve as a decision support tool with regard to the financing and implementation of appropriate risk management strategies in the public and private sector.

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Managing risks to improve farmers' livelihoods

Platform for Agricultural Risk Management

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Platform for Agricultural Risk Management

Assessing value chain risks to design agricultural risk management strategies

A practitioner's toolkit

Annexes

TOOLKIT

CAPACITY DEVELOPMENT


PARM
PLATFORM FOR
AGRICULTURAL RISK
MANAGEMENT

Platform
for Agricultural
Risk Management

Managing risks to improve farmers' livelihoods

Assessing value chain risks to design agricultural risk management strategies

A practitioner's toolkit

Annexes

PARM (2021)

Assessing value chain risks to design agricultural risk managment strategies: A practitioner's toolkit
by Alliance of Bioversity International and CIAT

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PARM/IFAD: Rome, Italy.

Table of contents

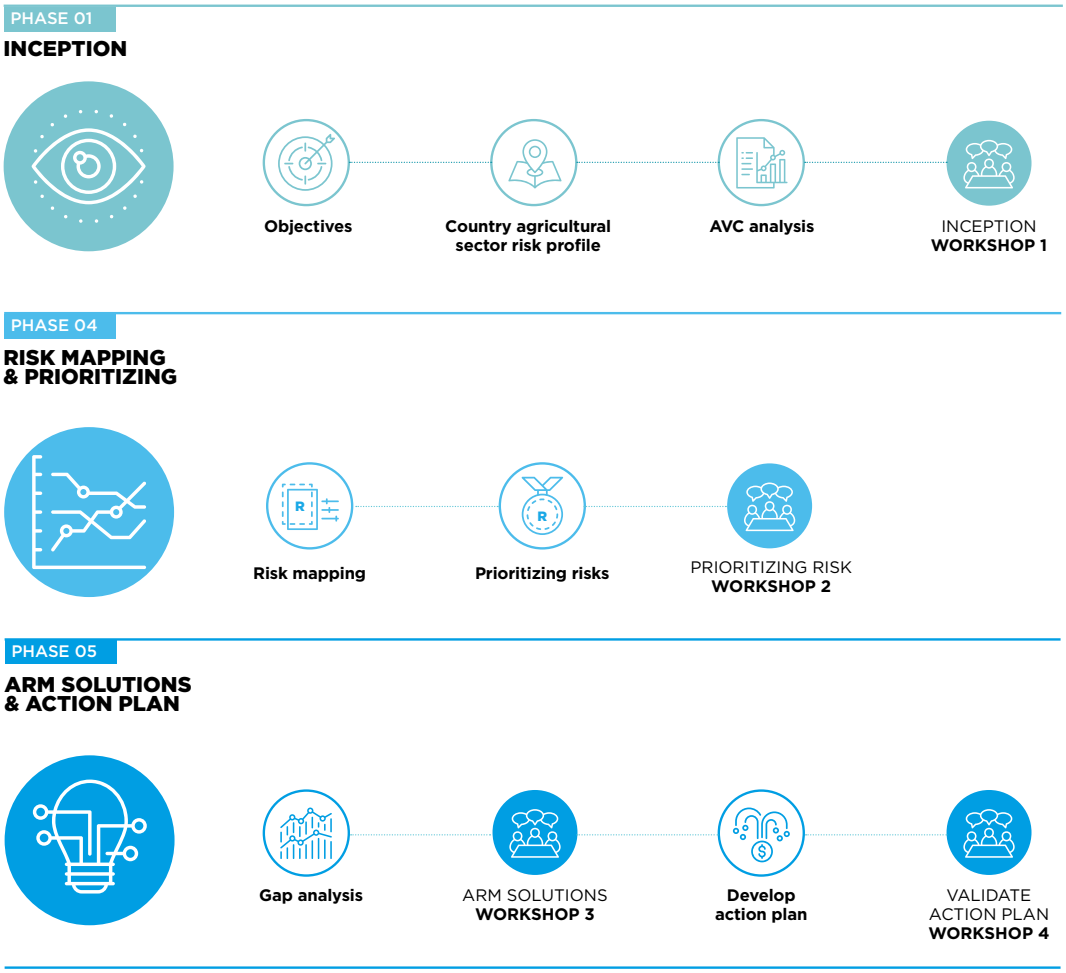
Acronyms

AR	Accessibility or Applicability Rating
ARM	Agricultural Risk Management
AT	Assessment Team
AVC	Agricultural Value Chain
AVC-RAS	Agricultural Value Chain Risk Assessment Study
CDD	Maximum number of Consecutive Dry Days
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station
CHIRTS	Climate Hazards Group InfraRed Temperature with Station
CIAT	International Center for Tropical Agriculture
CMR	Capacity to Manage Risks
CPI	Consumer Price Index
CRVA	Climate Risk Vulnerability Assessment
CV	Coefficient of Variation
EM-DAT	Emergency Events Database
ER	Effectiveness Rating
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
FOB	Free-On-Board
G20	Group of Twenty
GDP	Gross Domestic Product
GIS	Geoinformation System
HDZ	Hazards combination layer
HI	Thermal Index
ICRW	International Centre for Research on Women
IFAD	International Fund for Agricultural Development
ILO	International Labor Organization
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
KII	Key Informant Interview

LGP	Length of Growing Period
M4P	Making Markets Work Better for the Poor
MOA	Ministry of Agriculture
NDD	Number of dry days during the growing season
NDWS	Number of days with a ratio of actual to potential evapotranspiration below 0.5
NGO	Non-Governmental Organization
NT35	Total number of days with maximum temperature greater or equal to 35°C
NT-X	Number of days with temperatures above a threshold of X ºC.
NWLD	Number of days during the growing season with waterlogging in the soil
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PARM	Platform for Agricultural Risk Management
PCA	Principal Component Analysis
P5D	Maximum 5-day running average precipitation
P95	The 95th percentile of daily precipitation
PPI	Producer Price Index
SD	Standard Deviation
SLGP	Start of the growing season
TAI	Thornthwaite's Aridity Index
THI	Temperature Humidity Index
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNISDR	United Nations International Strategy for Disaster Risk Reduction
USAID	United States Agency for International Development
VI	Vulnerability Index
WTO	World Trade Organization

Annex A: Workshops

Workshops Occur during 3 phases, Phases 1, 4 and 5.



This toolkit is dependent on a series of stakeholder workshops as decision support instruments along the sequences of the AVC-RAS process. Figures I.1 and I.2 of the main document show the sequential role and timing of the workshops in the overall process. This Annex describes relevant workshop strategies in section A.1 as well as detailed guidance for each workshop in subsequent sections A.2 to A.5. References to this Annex can be found in various sections of the main document (I.3, 4.2, 5.2).

Content

A.1. Workshop strategies

Introduction

The workshops are key to the VC-RAS. This approach foresees the stakeholders to be consulted and in charge of making crucial decisions, such as defining the objectives and scope of the study, deciding on the short list of relevant risks and AVC actor groups as well as choosing appropriate solutions to be summarized in an action plan.

These workshops also require intensive preparation in the form of data gathering – including literature review, data analysis, and in-depth interviews with key experts and value chain stakeholders. An experienced group of facilitators and a well-planned agenda are additional essential prerequisites for ensuring a successful outcome for each workshop. If this number of workshops are difficult to be organized for specific reasons, it is suggested to combine workshops 2 and 3. If feasible from a technical point of view, some of the workshops could be conducted online via video conferencing tools. Specific guidelines are provided on how to organize a workshop by video conference.

Participants and their roles

Throughout these workshops, different participants have distinct roles to support various decision-making processes, such as the choice of which AVC(s), risks, and risk management solutions to prioritize. The AT will participate as a neutral facilitator and informant, helping to guide conversation and record key responses and contributions from participants. Stakeholders invited as guests will act as consultative actors to provide input and additional information to guide decision making. The steering panel or a defined group of participants will be in charge of making the final decisions.

The composition and format of interactive events with stakeholders should consider social and cultural contexts. The AT is responsible for applying gender-sensitive and inclusive approaches by establishing mixed-gender field teams, selecting suitable locations, guaranteeing privacy, and making gender a cross-cutting theme of the analysis, workshops, and instruments. To ensure gender is foundational to their analysis, the AT may create working groups that focus on the topic or ask participants gender-sensitive questions (PARM 2019b). More information on centering gender can be found in the document "Practical Tips for Conducting Gender-responsive Data Collection" (Elias 2013).

While representation of diverse actors is crucial, the AT should be aware of the consequence of inviting specific participants such as public or private representatives of specific value chains, sector representatives, and government officials to the discussion in the workshops. Some stakeholders may have strong interests, and unbalanced participation may bias the discussion. Therefore, important decisions must rely solely on the steering panel, while the information provided by these stakeholders functions as advice only. As the moderator and facilitator, meanwhile, the AT should ensure that the opinions of different participants are considered and that decisions are not governed by one dominant group of participants. Further information about how to moderate such stakeholder discussion is provided below.

Workshop best practice

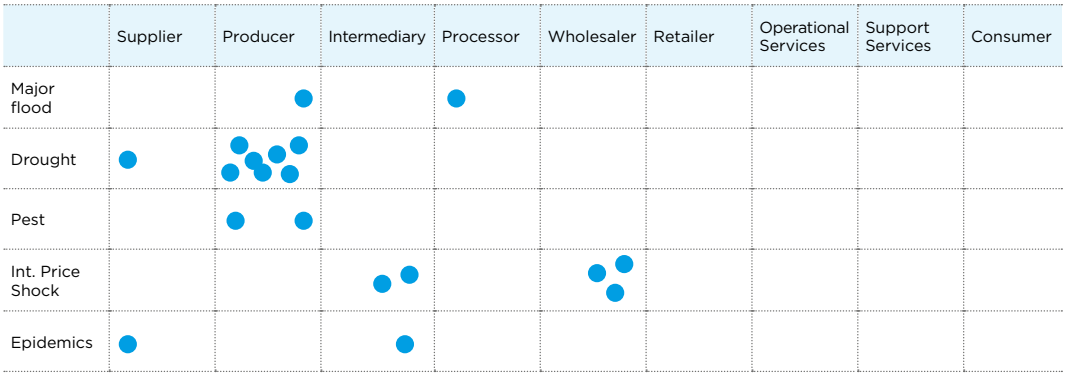
The AVC-RAS workshops are all about decision making, and within this process, a variety of opinions will have to be balanced. There are a number of techniques that can streamline discussion and facilitate this goal. Presenting a clear set of ground rules at the beginning of each workshop will encourage the different actors to participate and engage in the activities and keep the program flowing smoothly. Some examples of ground rules include the following:

- Switch off all phones or put them in silent mode.
- Do not talk on the phone during the activities.
- Do not hesitate to ask the facilitating team questions.
- All opinions and points of view are valid, and we encourage your participation.
- Be mindful, however, of the timing of your interventions.
- Be respectful of other people's views.

Decision making in groups

In some workshops, it will be necessary to conduct votes about important issues. There are several methods to do so successfully. If the workshop takes place in person, the facilitator can list items under discussion on a flip chart, provide each participant with a predetermined number of dot stickers, and then let participants place the stickers on their preferred items on the flip chart. The items that receive the most votes are chosen. The results will look like the ones presented in Figure A.1, which pertains to the prioritizing risks and AVC actor groups.

Figure A.1. Example of a voting board.



Virtual Meetings: In case a physical gathering is not feasible, most often, stakeholder workshops can be performed virtually as videoconferences. In this case, we recommend dividing longer workshops into segments with breaks interspersed to give participants an opportunity to refresh their energy and focus, and to allow the AT time to debrief after each session and prepare for the next one. If the workshop is virtual, instead of voting with dot stickers, some videoconferencing tools have an integrated polling function. Otherwise one of the following real-time voting options can be used: Socrative (open source), QuickSurvey (open source), Mentimeter, Slido, or SurveyMonkey. The applicability of these tools depends on the internet connectivity in the local context. Holding the workshops in person has benefits. For instance, interspersing items on the workshop agenda with less formal activities—e.g., coffee breaks, lunch, mixers, or roundtable discussions—can help sustain the energy, attention, and engagement of the participants, as well as serving to reinforce the informal relations between diverse actors along the value chain. In reality, a semi-virtual format might be the most feasible where some participants are on-site while others are joining virtually. In a hybrid setting, the virtual voting mechanisms can be used as explained for the virtual format, and participants can use their mobile phones for voting, if they have one.

In order to resolve any conflicts between stakeholders during the workshops, the facilitator should reorient the conversation around the objectives of the workshop or of the AVC-RAS, dividing the workshop into small groups for more in-depth discussion before bringing everyone back together to find a resolution, and taking a vote.

A.2. Workshop 1: Inception workshop

Workshop 1 is taking place in week 1 and corresponds to chapter 1 of the main document.

Objectives

The inception workshop should mainly be used to introduce the process and purpose of the AVC-RAS and gain the participants' attention in order to involve them into the study or the implementation of the action plan later on. Therefore, the participants of the workshop get an overview and agree on the objectives and scope to which the study should be oriented. Furthermore, the meeting can be used to develop a first short-list of risks relevant for the AVC and set the framework for the risk scoring that will take place after the risk analysis and before the next stakeholder workshop.

Preparing workshop 1

The assumption is that the client's overall objectives (e.g., agricultural GDP, food security, etc.) and scope of the VC-RAS, including the AVC selected for the study were defined before the study starts. In preparation of the workshop,

- the Assessment Team summarizes the process, objectives and scope of the study, and
- develops a first proposal of the categories to be used for a risk scoring after the risk analysis (section 2.2), based on the objectives of the study.

The Assessment Team will invite participants. We recommend setting aside 5-6 hours to present the process, discuss objectives and scope, brainstorm and decide on a short-list of risks, and define the risk scoring framework. If the meeting is virtual, we recommend convening 2 separate sessions of 2-3 hours each, one for presenting the objectives and scope, and a second session for the short-listing of risks and definition of the risk scoring framework. In that case, the second session can also take place later in the work plan.

Agenda

1. **Introduction:** A member of the AT facilitates the meeting. The facilitator starts with a round of introductions of the team and the steering panel. Depending on the size of the meeting, other stakeholders may be introduced as well. The facilitator presents the purpose and context of the planned VC-RAS, explaining the process of completing the study, its time frame and expected results, and the various activities involved. The AT describes how to set the objectives. This toolkit recommends a participatory process. Sometimes, however, depending on the decision makers present, the number of participants, and the local context, a less democratic process may be appropriate.

2. **Objectives setting:** The AT explains how the definition of objectives is relevant to the risk assessment. Specifically, the objectives guide subsequent work. The AT presents an overview of relevant strategic programs that are in place in the country. The AT then introduces the suggested objectives, the selected AVCs, and the geographical scope to provide the basis for the VC-RAS. The AT receives input from the plenum and adds new ideas to the list of objectives or considerations with regard to the scope. We recommend defining only a few guiding objectives – perhaps two or three. A vote may be necessary to discern the most supported objectives (see section 1.2 for further details).

3. **Composing the first short-list of risks:** This brainstorming comes at a very early stage where no additional information about the AVC is yet collected. Depending on the composition of participants, the Assessment Team decides whether this exercise would support the process and provide guidance for the further risk assessment. The AT facilitates a first brainstorming that leads to a long list of potential risks that affect the different actors of the selected AVC. Considering the number of participants, the brainstorming can be done in plenum or in groups. The facilitator goes through the complete list of gathered risks and clarifies any questions with regard to the list. Via a voting exercise as illustrated in Figure A.2, the relevance of the risks in the long-list is rated by the participants. This voting leads to a short-list of risks that is based on the participants' judgment and can provide guidance and focus for the Assessment Team's following risk analysis.

4. **Defining the risk scoring framework:** To prepare for the eventual risk assessment of the selected AVC, the facilitator describes the purpose of the risk scoring framework for a later prioritizing of the risks (see chapter 4). For scoring the risks, information about the risks' probability of occurrence and their impact on the AVC needs to be assessed and assigned to categories. The risk scoring framework foresees five impact categories of (1=negligible, 2=moderate, 3=considerable, 4=critical, 5=catastrophic) and three categories of probability (1=occasional, 2=probable, 3=highly probable). The scoring criteria and categories need to be defined by the workshop participants based on the objectives defined at the beginning of the workshop (e.g., agricultural GDP, food security, etc.), The AT can suggest initial of criteria and categories (see Tables 2.2 and 2.3 in the main document) relevant to the objectives. For scoring the risks' impact on the AVC, these criteria could be a selection of the following examples:

   - x% reduction in AVC production or income (World Bank, 2016)
   - significant income losses impacting x% or more of the actors engaged in the AVC
   - significant impacts felt by at least x% of women or young farmers e.g., temporary or permanent shutdown of parts or all value chain

   Then, participants reflect on the criteria and thresholds for each category, defining how a catastrophic, a critical, a considerable, a moderate or a negligible on the AVC should be measured. Likewise, they should decide on the thresholds to measure probability of occurrence for the three categories: occasional, probable, and highly probable.

   The AT should first present and explain the proposed criteria and categories. Next, the participants should discuss the criteria. Depending on the number of participants in the meeting, the discussions can be broken into groups and discussion results presented to the plenum. The facilitator will moderate the discussion, reminding participants that comparing risks and prioritizing them will be easier if fewer criteria are chosen.

Participants should always remain open to expressing one criterion in terms of another. Price volatility could, for example, be expressed in terms of profit losses or a reduced food security. We recommend defining a maximum of 4 criteria for measuring a risk's impact on the AVC. If more than one AVC is selected, the choice of impact criteria might differ. For defining thresholds such as specific percentages, the facilitator could create small groups, with each group defining the categories for one criterion. Then, each team presents their categories with explanations to the rest of the panel, and adjustments are made based on their input.

5. **Next steps:** The facilitator gives an overview of the planned next steps with the meeting participants, namely, Workshop 2 for risk prioritizing after the risk assessment.

A.3. Workshop 2: Risk prioritizing

Workshop 2 is taking place in week 9 and corresponds to section 4.2 of the main document.

Objectives

The objective of this workshop is to discuss the list of prioritized risks and AVC actors and a proposition of priorities with relevant stakeholders in order to agree on a prioritized short list of risks and actors. The decision should be based on AT's preparation and judgment, and an informed discussion and decision by stakeholders attending the workshop in Week 9. The decision will be based on stakeholders' judgment but should be guided by the scores and information provided by the AT.

Box A.1. Planning Workshops 2 and 3

We suggest planning a whole day for this workshop, or two half-day blocks if it takes place virtually, to allow time for discussion and resolving any disagreements. The results of the AT's prioritizing exercise should be shared with participants beforehand. After this workshop, the AT should schedule a conclusion meeting to define the final short list of risks for further consideration to develop the ARM strategy. If necessary, workshops 2 and 3 can be conducted together. This means that a second, day-long workshop follows immediately upon this prioritizing exercise. The objective of workshop 3 is to define a short list of ARM solutions to compose an ARM strategy based on the risks identified. Both workshops are expected to take 1 day and could be merged into a large 2-day workshop, but they are discussed separately below as they are organized differently.

Preparing workshop 2

After visualizing the identified risks for all relevant AVC actors and all AVCs, the risks are going to be prioritized by defining a short list. It is time to engage the stakeholders that will be implementing the risk management strategy and the final action plan. To this end, the AT will organize a stakeholder workshop to review and prioritize the analyzed risks. In preparation, the AT will generate visualizations of the risk assessment results (section 4.1) and suggest a first shot at risk prioritizing. The methodological results presented at the workshop serve as the basis for discussion of prioritizing by stakeholders. This prioritizing involves some degree of subjective judgment by stakeholders and decision makers based on the quantitative process presented to them by the AT, since it involves their personal considerations and potentially their vested interests. By incorporating the results from the risk and vulnerability assessment and following suggested steps, however, the AT can make the prioritizing process as objective, transparent, and traceable as possible. All components of decision making should be documented and explained. The following prioritizing process should be adapted based on the particular objectives and client interests of the VC-RAS.

Section 4.1 presents a list of questions and visualizations that could be relevant for the exercise of prioritizing risks. Which questions and data representations are relevant for the prioritizing risks depend on the objectives of the AVC-RAS.

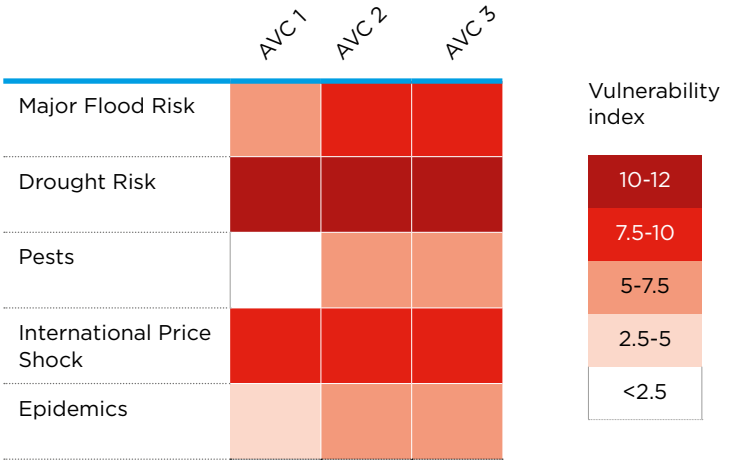
The following paragraphs propose an approach how risks could be prioritized as an input for the discussion in workshop 2. We recommend the following steps to identify the most important risks and actor groups for developing the action plan:

1) Ranking of risks

2) Ranking of vulnerable actor groups

The first step, **ranking the risks**, starts with a comparison of the selected AVC's vulnerability indices. The vulnerability index (VI) integrates risk scores as well as the CMR and can be considered as a good variable for comparing risks. A heat map is a useful instrument to visualize the AVC's different VI scores (Figure A.2).

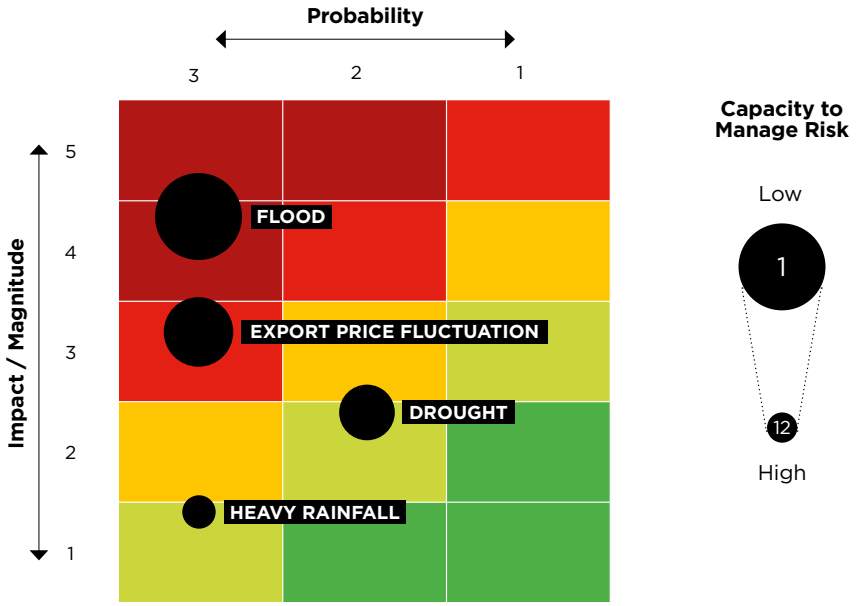
Figure A.2. Sample heat map of the vulnerability indices of three agricultural value chains.



Based on this heat map, the AT can select the most pressing risk for each AVC. Considering the values of each AVC's yearly production enables a better assessment of the relevance of identified risks to the agricultural sector. If the client wishes to prioritize risks across all AVCs, the AT can apply a weight representing the AVC's production value to the VIs. This will support direct comparability of the VIs of different AVCs and allow for prioritizing risks across the whole set of AVCs. However, in most cases, this step is not required, and prioritizing risks for each AVC meets the client's needs.

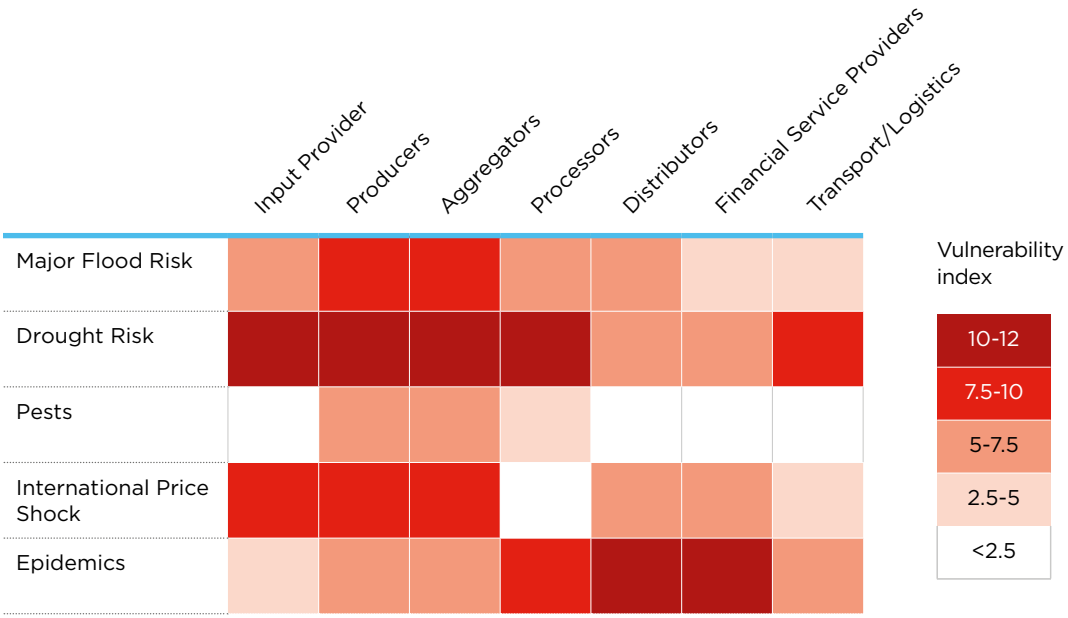
To validate the selected short list of risks, we also recommend preparing the risk matrix for each AVC, including information about the CMR (Figure A.3). Based on the resulting matrix, the AT composes a second short list of prioritized risks. As a validation, the two short lists are compared, and the AT synthesizes a final short list.

Figure A.3. Sample risk matrix for risk prioritizing.



The second step enables identification of the most vulnerable actor groups. In this step, a heat map is produced for each AVC, showing the short list of risks and the VI for each actor group (Figure A.4). Based on the VI values, the AT can identify which actor groups are most vulnerable to these risks and make a short list of actors to address in the action plan.

Figure A.4. Sample heat map for actor group prioritizing.



The workshop 2 will be used to reassess the ranking and arrive at an agreed-upon, final short list of risks and actors to consider in developing an action plan, using the agenda described below.

Agenda

1. **Introduction:** The facilitator opens the workshop with a reminder of the objectives and purpose of the VC-RAS. The objectives are written down on a flipchart to make them visible to all stakeholders present at the whole workshop. This should ensure that prioritizing risks will be oriented around these objectives. The facilitator then provides an overview of the prioritized value chain(s) with relevant key characteristics. To conclude the introduction, the AT presents the methodologies and processes involved in the risk and vulnerability assessment with an explanation of the scoring categories and calculations used.
2. **Presentation of the assessment results:** The facilitator then sets out the results of the assessment. He or she communicates the historical timeline of risk events as well as the different perspectives and prioritizing questions. The facilitator also furnishes corresponding visualizations of vulnerability, risk, and CMR for each AVC actor to further enrich participants' understanding (section 4.1). The facilitator concludes the presentation of results by presenting the suggested short-list of risks and actors, based on the AT's preparations for this workshop, and clearly explain the choice.

3. **Review of the risk prioritizing:** The stakeholders should validate the short-list of risks and actors. The AT divides the audience into groups that might have similar interests, such as AVC actors, NGO representatives, government representatives, or gender-disaggregated groups if relevant. The AT then assigns a facilitator to each group, and then limits itself to just facilitating group discussion and ensuring that the process is objective. This means that each participant should be given room to express his or her opinion, and a facilitator should point it out if a group is biased by the opinion of individual participants. The facilitators should be aware of the roles of the different actors and their interests and ensure that particular participants do not become dominant in the discussion. See section A.1 of this Annex for more information about how to keep the discussion fair and balanced. The decision process may proceed along the following steps:
    1. The AT distributes the short list of prioritized risks and AVC actor groups as well as visualizations to each discussion group.
    2. Each group then assesses the risks based on the various visualizations as well as the value chain actor's exposure and vulnerability. The facilitator collects critical thoughts and suggestions on a flipchart.
    3. Each group is provided with a table similar to the one in Figure A.1 in this Annex on a poster, including all the risks and AVC actor groups. Each group is assigned a color, and each participant receives three dot stickers in the color of her or his group. Then, each participant can mark her or his preferred areas of interest in the grids of her or his group's table - such as a combination of a particular AVC actor group and risk. He or she can place all three stickers on the same square, spread them across several options, or decide not to place any stickers.
    4. Following this vote, the preferences are discussed in small groups with the task of agreeing on three primary areas of interest for the group. If those interests are different than the ones suggested by the AT, the group agrees on a justification for the additional risks and/or actor groups.
    5. Each group assigns one representative.
    6. The AT draws the same table (Figure A.1) on a whiteboard and marks the sections that were proposed by the AT. Then, the facilitator gives three more dot stickers to the representatives of each group in the respective color of their group. The representatives then place the dot stickers on the table to mark additional risks or actor groups of interest according to their group. Each representative gives a brief explanation why the suggested areas of interest were chosen, and the AT documents the reasons with key notes on a flipchart.
    7. The AT builds clusters of common areas of interest and highlights if any conflicts exist among the perceptions of different stakeholder groups or between stakeholder interests and the ranking composed by the AT. If appropriate, the AT reminds the audience of the overall AVC-RAS objectives and asks each discussion group for a second statement, taking into consideration the arguments made by the other groups.
    8. The AT then composes a new, final short list of risks and/or actor groups that are of common interest to the stakeholders for further consideration for workshop 3.

4. **Next steps:** The facilitator concludes the risk prioritizing workshop and explains the next steps, namely developing an ARM strategy and action plan, which will require further involvement from workshop participants. Based on the short list of risks, the AT prepares a subsequent workshop 3 to define ARM solutions and strategies.

A.4. Workshop 3: Defining risk management solutions

Workshop 3 is taking place in week 10 and corresponds to section 5.2 in the main document.

Objectives

Workshop 3 will involve stakeholders to decide which ARM solutions to include in the action plan. The aim of this workshop is to identify a focus list of interventions to develop into an ARM action plan. As the workshop guidelines suggest, stakeholders such as the steering panel, government representatives, and experts from the private and development sectors should be invited (see section A.1). As stated in Box A.1, this workshop could be merged with workshop 2 on prioritizing risks if beneficial to the overall time plan. If this is the case, the AT should plan a meeting for consolidation and planning between the two workshops.

Preparing workshop 3

Preparation for this workshop is important since the workshop covers a wide variety of topics and presents large amounts of information to actors with different backgrounds and levels of knowledge. Therefore, it is necessary to program a full day of work or split the activities in two consecutive half-day sessions depending on the time availability of the actors and other considerations. In preparation, the AT should complete the following steps:

- provide relevant results from the risk and vulnerability assessment, risk prioritizing, and gap analysis in visual formats,
- prepare a gap analysis, a long list of ARM solutions and a short list of ARM strategies. Section 5.1 in the main document, explains in steps 1 to 3 how these three elements can be prepared before bringing them as inputs to the workshop. The gap analysis as well as the short list can be circulated during the workshop as documents, leaflets or posters.
- For evaluating ARM strategies, the AT refines the suggested list of criteria in the Agenda point 3 below based on the AVC-RAS objectives, and defines a set of criteria to be used during the workshop.

Agenda

We recommend the following 5 components as an agenda for the workshop, but the AT should adapt or change them to best suit their specific circumstances as dictated, for example, by the availability of information.

1. **Introduction:** Many of the actors will likely have participated in some activities of the risk assessment process and have interacted with each other in different scenarios. Nevertheless, there can be new participants with different levels of information and involvement, both as regards the assessment and value chain dynamics. Therefore, it is important to clarify the objectives of the project and the expected results of the workshop, as well as providing a space for all the participants to get acquainted with each other. Starting with an introductory session in which the participants share their organizational affiliations, and the expectations of the workshop can familiarize them with each other

while also giving them a chance to clarify their interests and positions. This information can be registered on cards and posted on one of the room's walls, so it is visible to every other participant and can be consulted during breaks and sessions. The facilitator builds small groups of participants that might have similar interests and perspectives on the AVC.

2. **Overview of the risk assessment process and results:** The AT presents the results of the risk and vulnerability assessment, the risk prioritizing, and the gap analysis that yielded the short list of ARM strategies. After this presentation, the AT can distribute handouts with information about proposed risk management strategies to each participant. Then, participants break out into discussion groups, and they are given 45 minutes to analyze the suggested strategies, gather questions and concerns, and volunteer additional input. Each group is accompanied by an assistant of the facilitator who clarifies any confusing points, moderates the discussion, and takes notes on the participants' comments and suggestions. After this, for the remaining 30-45 minutes allotted to this agenda item, the AT should first invite representatives of each group to present their ideas. Then, the AT will open space for plenary discussion to validate the short list of risk management strategies and include additional risk management solutions to complement these strategies. Finally, the facilitator creates an updated list of ARM solutions for further consideration on a flipchart.

3. **Evaluating the risk management strategies:** To narrow the list from proposed to a few final preferred ARM solutions, a rapid assessment of the solutions is performed using a decision filter. The AT can use the set of criteria offered below, or see also World Bank (2013) (Table A.1):

Table A.1. Criteria for evaluating ARM strategies.

Relative benefits	Adverse impact on the environment
Relative costs	Potential impact on poverty alleviation
Scalability	Effect on vulnerable groups
Ease of implementation	Gender inclusiveness
Return time	

The facilitator presents the list of criteria and clarifies with the plenum if these are the optimal criteria to select an ARM strategy. Based on responses from stakeholders, the facilitator refines the criteria. This first activity should take approximately 20-30 minutes. All the stakeholders present should provide assessments of the criteria for each of the ARM solutions, within another time frame of 20-30 minutes. The assessment can be based on professional judgments by stakeholders present at the workshop, by applying simple categories of answers: for example, yes or no; low, medium, or high; or short, medium, or long (World Bank, 2013). The assessments of each stakeholder can be gathered through anonymous questionnaires or polling tools, such as the ones described in section A.1, if internet connectivity allows it. The participants should submit their responses without interacting with each other in order to prevent a bias towards the interests of a particular group of stakeholders.

After collecting all the answers, the AT announces a 30-minute break for the participants, during which the AT evaluates the results. After reconvening the workshop, the facilitator presents the results and conclusions. The plenum should be given the chance to intervene and discuss. If conflicts arise, a vote or a discussion in sub-groups might make sense to resolve the issues. Based on this rapid assessment, a final list of a few prioritized ARM solutions is selected and validated by the plenum. Sixty minutes should be budgeted for this discussion.

4. **Gain stakeholders' opinions and additional information:** Based on this final list of ARM solutions, the workshop participants can be divided into two or three subgroups to start collecting details on a potential action plan, including the selected focus list of options. Each group will be tasked with brainstorming and writing down characteristics of a potential action plan for one or two ARM solutions. This action plan should be feasible and within the scope of participating organizations. While detailed outcomes, activities, and figures will not necessarily be delivered during the workshop, they can arrive at an advanced version of the list of activities to be deployed along with information regarding at least the following eight elements (ISO, 2009b):
   a) characteristics of the risk including probability, average loss, annual average loss, maximum loss, and CMR; suggested risk management measures and beneficiaries; reasons for selecting these measures; expected benefits including gender responsiveness;
   b) accountable person(s), institution, or department for approving the plan;
   c) accountable person(s), institution, or department for implementing the plan;
   d) proposed activities;
   e) resources required, including contingencies and suggested funding sources;
   f) performance measures and constraints;
   g) reporting and monitoring requirements; and
   h) timing and schedule.

   The AT can use a table to structure this exercise. To guide this activity, the facilitating team will take notes about participants' contributions and display them on a large and visible surface, using, for instance, blackboards, pin boards, or colored cards and markers. To increase engagement, stakeholders can help taking notes and complement different elements of the action plan according to the metaplan technique. Ideally, facilitators will collect estimations of resources and time required for each defined activity. In a group of 4-10 participants, this can be done for each activity or component by asking each participant to write an estimated number on a card without discussing it with anybody, given only 5 minutes for reflection. Next, all participants show their estimations to the group simultaneously. Finally, with moderation from the facilitator, a middle value is agreed upon. Depending on the context and past experience with workshops, the Assessment Team should decide whether these exercises are feasible to be performed with stakeholders and will provide valuable information.

5. **Summary and next steps:** The results of the exercise will be presented and validated in plenary. The facilitating group will outline the next steps and commitments from the AT and stakeholders that will produce a final action plan for approval in a fifth stakeholder workshop.

A.5. Workshop 4: Validating the action plan

The final workshop 4 is taking place in week 12 and corresponds to section 5.2 in the main document.

Objectives

The workshop is aiming to present final results of the AVC-RAS, validate the developed action plan and obtain clients' commitments to plan the action plan's implementation.

This capstone workshop will celebrate all that has been achieved in the course of the VC-RAS study. It involves decision makers from the government and relevant agencies, experts, representatives from the AVC, and NGO representatives. The action plan could be presented by government representatives or the client that would implement the action plan. We recommend discussing challenges and constraints for the plan's implementation, as well as potential partnerships or synergies with ongoing initiatives. Stakeholders will also be informed of the residual risk in the AVC that is not being addressed by the action plan and decide whether they want to address the remaining risks through other means. It will be pointed out that remaining and treated risks both need to be monitored and regularly reassessed to manage the risks to the value chain on a continuous basis (ISO, 2009b).

Preparing workshop 4

The final workshop 4 has specific requirements in terms of participants with the aim to build the bridge to the implementation of the action plan. Therefore, potential implementers and clients as well as investors, donors, and other interested parties should be considered. The AT should ensure that key actors with the interest and capacity to finance and implement risk management strategies are present at the fourth workshop, since it is geared toward validating the action plan, securing commitments to its risk management strategies, and outlining actionable next steps along with accountability for carrying them out.

This workshop will be the final activity of the AVC-RAS. It should be structured into two half-day sessions of which the first session is addressed to those participants that haven't been attending previous workshops. The first session provides an introduction and overview of the AVC-RAS process and results from previous activities. The second half-day session features a presentation of the final action plan, with room for discussion and input for its implementation. Dividing the workshop into two sessions allows participants who had not joined any previous workshops to get a good overview of the process by attending the first session.

Prior to the workshop, the AT will have finalized the action plan (section 5.1). The AT should also informally discuss the action plan with relevant government agencies, potential implementers and the client before the workshop in order to ensure that important questions or conflicts are solved before the workshop.

Agenda

1. **Introduction (half day):** The first session of the workshop should provide an overview of the process and results of risk and vulnerability assessment, supported by visualizations. This session will also explain risk prioritizing and gap analysis that led to developing a final list of ARM strategies. It could be divided into the following sub-sessions:

   a. Risk assessment and scoring process.
   b. CMR assessment and VI process.
   c. Risk prioritizing results with intuitive visuals, gap analysis, and a narrative.
   d. Final list of ARM strategies.
   e. Opportunity for clarification and discussion.

2. **Presenting and discussing the final action plan:** The final action plan is presented in detail. We strongly recommend arranging for a representative of one of the implementers to present and facilitate this session in order to give the team of implementers ownership of the plan and let them sit in the driver's seat. They should co-define the program of this session together with the AT to best leverage the talent in the audience. After the presentation of the action plan, specific working questions could be addressed to the audience for discussion in break-out groups. These questions ideally cover white spots or areas of insecurity in the action plan and ensure that participants learn from past experience with similar programs. Examples of such questions include the following:

   a. What financing scheme could be the most efficient and sustainable for this action plan?
   b. What lessons are relevant from past projects?
   c. How can the solutions address specific groups of actors such as women and young people?
   d. What constraints could affect implementation?
   e. Which synergies with other projects and programs exist with in this action plan?

   Each break-out group is moderated by a facilitating assistant and all responses are recorded. Representatives of the break-out groups or the facilitating assistants summarize their ideas to the plenum. The facilitator ensures that relevant responses are duly noted and considered as part of the action plan.

3. **Concluding the AVC-RAS and next steps:** In a last presentation by the AT, the stakeholders are informed about the residual risk in the AVC that is not being addressed by the action plan. The AT emphasizes that continuous monitoring and reassessment of risks is necessary. The client or the AT shares anticipated steps to implement the action plan and other actions related to the completed risk assessment. The result of the workshop should be an approved action plan with clear accountabilities for these next steps. If possible, the relevant stakeholders will sign a document demonstrating their commitment.

Annex B: Key literature, datasets and Indicators

Literature review and data analysis are the Assessment Team's (AT's) first research activities after the inception workshop and provide an overview of available information on the Agricultural Value Chain (AVC), risks the AVC is exposed to and risk management strategies in place.

For this, scientific publications, analytical country reports, key donor reports and selected gray literature will provide crucial information. Potential sources for relevant reports or statistics are institutions such as the World Bank, the FAO, major AVC producers or trading companies, trade organizations, CGIAR, government statistics or reports. Besides checking for these sources, the AT is expected to do a proper literature review, consulting the search engine of google scholar of at least five years, or sign up for free to ResearchGate[1] and academia[2].

This Annex provides some lists with references to literature and data sources that could be relevant to the Assessment Team for different stages of the AVC-RAS process. The following table of content contributes to a better orientation in this Annex:

1 https://www.researchgate.net/
2 https://www.academia.edu/

KEY LITERATURE

B.1. Methodologies for AVC Analysis

These correspond to section 1.3 of the main document.

- Springer-Heinze, A. (2018). ValueLinks 2.0. Manual on Sustainable Value Chain Development. https://valuelinks.org/
- Hakemulder, R.; Value Chain Development Team. (2015). Value chain development for decent work: how to create employment and improve working conditions in targeted sectors. 2nd ed. Geneva: International Labour Office (ILO), 2015. https://www.ilo.org/empent/areas/value-chain-development-vcd/WCMS_434362/lang--en/index.htm
- M4P. (2008). Making Value Chains Work Better for the Poor: A Toolbook for Practitioners of Value Chain Analysis. Version 3. http://www.fao.org/3/a-at357e.pdf
- Lundy, M.; Gottret, M. V.; Ostertag Gálvez, C. F.; Best, R.; Ferris, S. (2007). Participatory market chain analysis for smallholder producers. Good practice guide 4. The International Center for Tropical Agriculture (CIAT).
- USAID, (n.d). The value chain development wiki. MarketLinks. https://www.marketlinks.org/

B.2. Sources of information for inventory of existing ARM tools and policies

This corresponds to section 3.1 of the main document.

Relevant sources to be consulted for the inventory of ARM tools and policies include among others the following:

- Interviews with actors and stakeholders.
- Government information and reports on existing policies, services, and implementations.
- Websites of financial service providers.
- Datasets of International Monetary Fund.
- Reports and information from international organizations, NGOs, and research centers on the performance of existing ARM tools.
- Reports from cooperatives and farmers‘ organizations.
- Food Safety in Africa from the World Bank, which provides access to descriptive information about 518 food safety investments in Sub-Saharan Africa between 2010 and early 2017.
- OECD Policy Monitoring and Evaluation reports (e.g., OECD, 2020).

B.3. Sources of information for gender-differentiated ARM tools and policies

This corresponds to sections 3.2 and 5.1 of the main document.

- Mrdalj and El Bilali (2019) propose policy interventions for inclusive value chains.
- PARM's "Gender in agricultural risk management" (2019b) provides examples and an overview of gender-responsive ARM tools and strategies.
- FAO provides the "Developing gender-sensitive value chains: A guiding framework" (2016a).
- FAO's "Developing Gender-sensitive Value Chains" (2018a) provides guidance on integrating gender-sensitive solutions into AVC interventions, e.g., regarding women's access to financial services, inputs, and technologies.
- FAO provides a "Guidance note on gender-sensitive vulnerability assessments in agriculture" (2018b).
- OECD published "Gender Inequality in West African Social Institutions" (Bouchama, et al. 2018).
- World Bank provides the "Gender and Agricultural Risk: A gendered approach to agricultural risk assessment management strategies" (2017) as well as the "World Development Report 2012: Gender Equality and Development" (2012).

For disaster risk reduction, which specifically focuses on catastrophic events, the following studies contain relevant approaches for gender-inclusive risk management strategies:

- United Nations Environment Programme (UNEP) (2005). Mainstreaming Gender in Environmental Assessment and Early Warning. UNEP: Nairobi.
- United Nations International Strategy for Disaster Risk Reduction (UNISDR) et al. (2009). Making Disaster Risk Reduction Gender-Sensitive Policy and Practical Guidelines. UNISDR, UNDP, and International Union for Conservation of Nature (IUCN): Geneva.
- United Nations (UN) Women (2012). Gender-Responsive Early Warning: Overview and How-to Guide. UN Women: New York.
- UNISDR (2015). Women's Leadership in Risk-Resilient Development – Good Practices and Lessons Learned. UNISDR: Bangkok.
- FAO (2016b). Gender-responsive disaster risk reduction in the agriculture sector. Guidance for policy-makers and practitioners. FAO: Rome.

B.4. Literature supporting the creation of a long list of risk management strategies

This corresponds to section 5.1 of the main document.

The following documents include tables of ARM tools and policies that can be useful for the identification of adequate, additional ARM tools for the AVC-RAS:

- "Module 3: Agricultural risk management tools. In "Agriculture Risk Management in Developing Countries: a learning course for practitioners" gives an overview of risk management tools that can be applied at farm level (PARM, 2018b).
- The World Bank's report on Agricultural Production Risk (2005) describes additional production risks and corresponding risk management solutions.
- The "Agricultural Sector Risk Assessment: Methodological Guidance for Practitioners" suggests strategies to address specific agricultural risks (World Bank, 2016).
- The Agricultural Sector Risk Assessment of Tanzania also includes examples of ARM solutions that were identified during the assessment and can serve as an inspiration to the AT (Arce & Caballero, 2015).

DATA SOURCES AND INDICATORS

B.5. Dimensions and Indicators for an Agricultural Sector Profile

These correspond to section 1.2 of the main document.

Indicators	Sources
Overall economic situation	
• GDP per capita in the last 10 years • Domestic interest rate • Nominal exchange rates • Real exchange rates • Rate of inflation	• World Development Indicators • FAOSTAT • National banks

(...)

(...)

Indicators	Sources
Economic relevance of the agricultural sector	
• % contribution of agriculture to GDP in last 10 years • Agricultural GDP in the last 10 years • Value of agricultural imports and exports • % contribution of agriculture to total imports & exports • 10 major agricultural products in terms of area and GDP • Value of major agricultural exports for the last 10 years and their % contribution to total exports • Value of major agricultural imports for the last 10 years and their % contribution to total imports • # of hectares under agriculture • % of agricultural area relative to the total area of country	• World Development Indicators • FAOSTAT • National statistics such as the census
People, livelihoods, and agriculture	
• Total population • % of population living in rural areas • # and % of people actively employed in primary production agriculture • % of women actively employed in primary production agriculture • % of rural population below the national poverty line, relative to the total population • % of population below the national poverty line, relative to the total population • % of youths (aged 15-24) who are literate • gender-disaggregated average monthly earnings from agricultural activities • Agricultural value-added per worker in the country • Gini index • Gender inequality index • % of population in absolute poverty • # of farms • farm size distribution (% of small, medium, and large farms) • % of female agricultural landowners • Distribution of employment in agriculture by gender • Agroecological zones	• World Development Indicators • National statistics such as the census • FAOSTAT • United Nations Development Programme (UNDP) Human Development Report • FAO Gender and Land Rights Database • United Nations Statistical Division UNSTATS Gender Statistics • UNDP Gender Inequality Index • World Bank Gender Statistics

(...)

(...)

Indicators	Sources
Food security, nutrition and health	
• Food security score (country) • % of people undernourished out of total population • Calories available from crop products or calorie supply per capita, crops equivalent • % of household income spent on food • Global hunger index • Other food security indexes, such as the food consumption score, household dietary diversity scale, or data on undernourishment	• The Economist Intelligence Unit Food Security Index • World Bank • Food Security Portal • National Health, Nutrition, and Population Statistics • Subnational Malnutrition Database • IMF • Global Yield Gap Atlas • World Development Indicators • FAOSTAT\ • Famine Early Warning Systems Network
Agricultural trade situation	
• Agricultural net trade situation • Agricultural gross trade situation • Important preferential agreements	• World Trade Organization (WTO) preferential trade agreements • National statistics • FAOSTAT
Domestic policies	
• Domestic price and quantity management • Subsidies	• Specific to the country under study.
Import and export policies	
• Tariffs • Non-tariff barriers • Export subsidies • Subsidized export credits • Indicators of protection support, e.g., nominal rate of protection (NRP) nominal rate of assistance (NRA).	• OECD producer support estimate • World Bank agricultural distortions database • AgIncentives

B.6. Datasets to Measure Risk Variables and indicators

These correspond to section 2.2 of the main document.

Indicators	Datasets and Sources
Agricultural GDP loss	
• Agricultural GDP	• FAOSTAT • World Development Indicators • IMF • MOA or National Bureau of Statistics
Production loss	
• Yield (t/ha) • Production loss ($, volume) • Commodity price • Post-harvest loss	• FAOSTAT • MOA or National Bureau of Statistics • African Post-Harvest Losses Information System • Agricultural Market Information System
Trade loss	
• Export value • Export volume	• World Integrated Trade Solution • Exporter Dynamics Database • FAO trade data • WTO export statistics
Endangered livelihoods	
• Income • Consumption • Consumer prices • Inflation rate • Loss of property or equity • Deaths, hospitalizations, or health impacts	• The International Labour Organization's ILOSTAT • World Development Indicators • IMF
Food insecurity	
• Nutrition • Health • Income • Consumption • Food supply • Consumer prices	• National Health Nutrition and Population Statistics • Subnational Malnutrition Database • IMF • Global Yield Gap Atlas • World Development Indicators • FAOSTAT • Famine Early Warning Systems Network • International Food Policy Research Institute

B.7. Datasets for gender-disaggregated measurements of vulnerability

These correspond to section 3.2 of the main document. A selection of relevant datasets for measuring gender constraints that can be an indicator of increased vulnerability are provided here:

- Rural Livelihoods Information System
- FAO Gender and Land Rights Database
- FAO Gender-related publications and assessments
- UN Gender Inequality Index
- The World Bank Data Catalog: Gender Statistics
- The World Bank Data Catalog: Gender Highlights
- OECD Development Centre's Social Institutions and Gender Index
- International Centre for Research on Women (ICRW). 2012. Capturing the Gender Effect. Guidance for Gender Measurement in Agriculture Programs. ICRW: Washington. https://www.icrw.org/wp-content/uploads/2016/10/ICRW-TZ-Gender--Agri-II-v7-1FINAL.pdf
- The Women's Empowerment in Agriculture Index (Alkire et al., 2012): https://www.ifpri.org/publication/women%E2%80%99s-empowerment-agriculture-index-0

B.8. Measuring Capacity to Manage Risks through indicators

These correspond to section 3.3 of the main document.

The indicators presented below can be clustered in three conditions: satisfaction of basic needs, capacity for innovation, and capacity for action (Palao et al. 2019).

Table B.1 shows an example of a list of indicators along the three mentioned clusters. It also contains potential sources, questions, and datasets. In addition, data can be found under the World Bank's Enabling the Business of Agriculture project which provides data about the following eight crucial indicators with national granularity: "supplying seed, registering fertilizer, securing water, registering machinery, sustaining livestock, protecting plant health, trading food, and accessing finance."

More information about the methodology is going to be available in the publication of a Climate Risk Vulnerability Assessment in the Philippines (Palao et al. 2019).

Table B.1. Details for extended CMR indicators list.

Criteria	Indicators	Potential Questions, Sources, and Datasets
Satisfaction of Basic Needs		
Water Security	Availability of drinking water for household consumption	Water depletion: Aqueduct Water Risk Atlas What is the main type of water source in the region – e.g., pipelines, surface water, wells, or springs?
Quality of Education	Educational level	Gender Disaggregated Labor Database What is your highest educational attainment? What is the quality of education in your locality? How many schools, including tertiary institutions and colleges, exist in your area?
	Literacy rate	Education Policy Data Center EdStats World Bank
Food Security	Market reliance for food	Are you dependent on locally produced agricultural crops? Characterize the availability of local produce. Describe your household characteristics.
	Dietary diversity	Subnational Malnutrition Database from the World Bank
Household or enterprise characteristics	Income	Subnational Poverty Data Gender Disaggregated Labor Database What is the main source of income in your area – e.g., commerce and trade, agriculture, or remittances?
	Household size	What is the average household size in your area?
	Employment	Gender Disaggregated Labor Database Characterize the availability of employment within or outside your locality.
	Human Development Index	Global Data Lab Subnational Human Development Index
	Value of properties	What is the average value of your property and belongings including appliances and furniture?
Health	Physical access to healthcare facilities	Health workforce WHO statistics Do you have access to hospitals and health care facilities? How many hospitals exist near you, and what is the ratio of doctors to the population?
	Quality of the healthcare system	How would you assess the quality of the healthcare system?
Only for climate risks: Deforestation rate	Forest coverage	Is there deforestation in your region? What is area of forest cover?
	Extent of soil erosion	What is the extent of soil erosion in your locality?

(...)

(...)

Criteria	Indicators	Potential Questions, Sources, and Datasets
Safety	Travel safety	Is it safe to travel for purposes of transit, transporting goods, and activities in your area without fear of suffering aggression or assault?
	Household safety	Have you experienced robbery within your household? Has this happened more than 5 times, sometimes, once, or not at all? Has your household been the victim of any other crimes? If so, which ones and how often?
Poverty	Purchasing power	How do you assess your buying power? Please rate it on a scale of 1-5, where 5=comfortable, 3=manageable, and 1=difficult.
Capacity for innovation		
Attitude	Attitude towards change	In the event of crisis and calamity, are you willing to change your livelihood? (5=absolutely, 3=maybe, 1=no)
Communication facilities	Use of information and communication technologies	Do you use any gadget for communication? How many devices, such as desktops, laptops, mobile phones, radios, television sets, do you own?
	Awareness about risk events	How do announcements about risk events reach you? For example, through television programs, radio programs, text messages, townhall meetings, emails, or message boards? How many of each of these communication channels do you utilize to learn about risk events?
	Social connectivity	Do you use social media for communication? How many apps do you use, such as Facebook, Twitter, and Instagram?
Business environment	Access to market information	Do you have access to market information?
	Legal framework	Are you aware if there is corruption in your locality?
	Certification	Is it easy to get certifications, such as quality certifications or certifications for organic produce, for your business? Please rate the ease or difficulty of obtaining certification on a scale of 1=difficult to 5=easy.
Social environment	Number and participation of local associations or organizations	Are you a member of any groups or association?
	Gender equity	Gender Statistics from World Bank Women's Empowerment in Agriculture Index How many women are participating in your firm?
	Participation of women in the private and public sectors	What is the share of women participating in the private and public sectors?

(...)

(...)

Criteria	Indicators	Potential Questions, Sources, and Datasets
Technical assistance	Access to extension services	Do you have access to extension services such as trainings or farm school?
	Access to technology	Do you have access to necessary technologies?
Capacity for Action		
Financial resources	Access to markets	Does your business have any branches or outlets?
	Access and use of insurance	Do you have access to insurance? Do you have insurance policies?
	Access to financial resources	Enterprise Surveys Database Please characterize the financial resources that are available to you. Do you have access to credit and loans, for instance through a bank, informal lending, or family and friends? Have you experienced difficulties in accessing credit and loans because of your gender?
	Number of banks	How many banks are present in your locality?
	Remittances	Do you receive any remittances?
	Access to hedging instruments or capital markets	Do you use any hedging instruments or capital market instruments?
	Value of productive assets	How much is the assessed value of your productive assets, such as land and buildings?
Labor	Labor availability	What is the labor availability in your region? Please rate labor availability on a scale of 1-5, where 5=always available, 3=seasonal, 1=insufficient.
	Diversity of income sources	Do you have alternative sources of income that are not from the AVC under review?
Support and infrastructure	Assistance during hazard events	Do you receive any assistance during extreme events from the government, private sources, or NGOs?
	Support facilities	Do you have access to any support facilities such as storage warehouses or trading posts?
	For producers: Access to irrigation	Do you have access to irrigation for crop, livestock, and farm needs?
	For producers: Farming practices	Do you use new and innovative farming practices?

(...)

(...)

Criteria	Indicators	Potential Questions, Sources, and Datasets
	Access to electricity	Do you have access to electricity?
	Types of roads and road density	What types of road exist in your locality – e.g., asphalt, concrete, rough road, or gravel? Access to transport: Rural Access Index from the World Bank
	Presence of cell sites and communication towers	How many cell sites and communication towers exist in your locality? (This information is a proxy for the number of service providers)
Land tenure	Type of land ownership	How would you classify your land ownership? For instance, is your land titled, rented, or leased, or do you have land rights?

B.9. Sources and datasets for information about weather risks

These correspond to section 2.2 of the main text and Annex J.

Drought	Interactive maps: • International Research Institute for Climate and Society Maproom for Drought Monitoring • FAO Global Information and Early Warning System Other datasets: • Sentinel • ERA5 • Historical and future daily data such as Coupled Model Intercomparison Project Phase 5 and Phase 6 (CMIP5, CMIP6) • Global Drought Observatory • Heating & Cooling Degree Days - Free Worldwide Data Calculation • GeoWRSI • Aqueduct Water Risk Atlas • EM-DAT • National sources
Flood	• Sentinel (guide for developing flood maps with Google Earth) • The Flood Observatory • Global Flood Awareness System (GloFAS), free but requires registration • ERA5 • Aqueduct Water Risk Atlas • Open-source Nat Cat models: Oasis platform • EM-DAT • National sources
Storm or hurricane	• Sentinel • ERA5 • EM-DAT • National Oceanic and Atmospheric Administration historical hurricane tracks • National sources

B.10. Indicators to measure price risks

These correspond to section 2.2 of the main text.

Actors	Possible Indicators	Description and Scope	Period	Sources
Input suppliers	Average retail prices for key inputs such as fertilizers, pesticides seeds and diesel.	Indicator of the variability and predictability of input prices.	Inter-annual and intra-annual for 15 to 30 years	Input supply companies
Producers	Average retail prices for key inputs such as fertilizers, pesticides, seeds and diesel Inter-annual Producer Price Index (PPI) Inter-annual Consumer Price Index (CPI) Seasonal variability in prices Average farm-gate price for focal commodity ($ per metric ton) Average domestic or into-factory prices ($ per metric ton)	Indicator of variability and predictability of input prices. PPI: Indicator of the rate of change in commodity prices after they leave the producer. Used an indicator of the movements of prices in the economy. CPI: A measure of price changes for purchasing households. Commonly used to determine and monitor inflation. Ratio of maximum farm or wholesale commodity price to minimum farm or wholesale price within a seasonal time frame. Indicator of patterns of seasonality or variability at the farm-gate level and at the wholesale and retail levels for a domestically marketed commodity.	Inter-annual and intra-annual for 15 to 30 years	Input supply companies PPI: FAOSTAT OECD Producer Price Indices CPI: FAOSTAT OECD MOA or industry associations

(...)

(...)

Actors	Possible Indicators	Description and Scope	Period	Sources
Intermediaries	Real exchange rate Ratio of average free-on-board price (FOB) to comparative international price ($ per metric ton) Seasonal variability in prices	Nominal exchange rate that accounts for the inflation differentials among countries. Indicator of exchange rate level and volatility. For traded commodities, the ratio between average FOB values and benchmarked international prices per metric ton. Indicator of price trends, volatility, and the level of premium or discount to international prices.	Inter-annual and intra-annual for 15 to 30 years	Real Exchange rate: The World Bank IMF FOB: National and international commodity agencies

(...)

(...)

Actors	Possible Indicators	Description and Scope	Period	Sources
Processors	Inter-annual PPI Inter-annual CPI Seasonal price variability Average retail prices for key inputs or farmers' output	PPI: Indicator of the rate of change in commodity prices after they leave the producer. Used an indicator of price movements in the economy. CPI: A measure of price changes for purchasing households. Commonly used to determine and monitor inflation. Ratio of maximum farm or wholesale commodity price to minimum farm or wholesale price within a seasonal time frame. Indicator of patterns of seasonality or variability at the farm-gate level and the at wholesale and retail levels for a domestically marketed commodity.	Inter-annual and intra-annual for 15 to 30 years	PPI: FAOSTAT OECD CPI: FAOSTAT OECD MOA and industry associations

(...)

(...)

Actors	Possible Indicators	Description and Scope	Period	Sources
Traders	Real exchange rate Ratio of average FOB to comparative international price ($ per metric ton) Average domestic and international prices ($ per metric ton) Seasonal price variability	Nominal exchange rate that accounts for inflation differentials among countries. Indicator of exchange rate level and volatility. For traded commodities, the ratio between average FOB values and benchmarked international prices per metric ton. Indicators of price trends, volatility, and the level of premium or discount in international prices. Indicator of the price volatility of certain commodities and of predictability in domestic and international markets.	Inter-annual and intra-annual for 15 to 30 years	Real exchange rate: The World Bank International Monetary Fund FOB: national and international commodity agencies

Annex C: Interviewing

The most important source of information for an AVC-RAS is interviews with AVC experts and actor groups. Interviews with diverse actors are crucial at almost every stage of the AVC-RAS process.

Interviews can unearth significant historical risk events that have impacted an AVC and can shed light on actors' perceptions of their risk exposure and of the consequences these risks have had for their livelihoods in terms of business and productivity losses. To aid in the risk assessment process (Chapter 3), interviews should include questions about the stakeholders' roles in the value chain; their relationships with upstream and downstream actors; their expectations about trends and variability based on their experiences; and problems they have encountered including information about their sources, effects, and severity. Interviews may also ask about stakeholders' strategies to manage these problems and risk management gaps.

Due to the importance of this activity to the overall study results, the interviews with AVC actor groups require detailed planning. The time frame can be adjusted depending on the number of selected value chains, their geographical distribution, and the number of enumerators available. In many cases, we recommend running the interviews in different geographical locations and with different actors of the value chain in parallel. The work plan in this toolkit entails a tight schedule, and therefore, the number of interviews cannot meet rigorous scientific requirements and will not reach representative sample sizes. Yet the AT should aim for maximum representation within the scope and related restrictions of the study.

The following sections will provide guidance on four relevant aspects to consider for the interviews:

C.1. Ethics in Interviewing

As researchers, the AT is bound to rules of ethics. All processes involving data collection with human subjects such as KII, FGD and workshops should comply with minimum requirements concerning the rights, safety and protection of the participants and their personal information, by obtaining an ethics clearance before interacting with the subjects. Ethic clearances can be requested with the own institutions' internal review board, ethics committee or from national, regional or local government offices. The AT should plan ahead and consider the time necessary of this clearance, as this may vary depending on the reviewing institution. In particular, one-on-one structured interviews may require clearance depending on the questions to be asked, and what is considered sensitive may vary across countries, socio-economic groups, and by gender. Ethical clearances may be required by both the implementing institutions internal committee and from country government committees or other provincial/regional or local district offices.

While it is appropriate to acknowledge people, who are interviewed and stakeholders attending the workshop in the report chapter "Sources and Methodologies" or the Annex of the AVC-RAS report, **they should not be acknowledged without their consent**.

C.2. Assessing Risks: Semi-Structured Interview Questions for Different Actors

A novel contribution to supporting the interview process are questionnaires that can be used to interview AVC actors, AVC experts, and ARM solutions experts. (Jaffee et al., 2008; World Bank 2016; PARM, 2019b). A list of suggested questions can be found in the attached spreadsheet in Annex H.

Key themes addressed in the different modules are:

1. General information on the actor
2. Value chain characterization
3. Risk Identification and analysis
4. Transmission of risks
5. Inventory of existing ARM tools and policies

The variety of different actors includes producers, aggregators, processors, distributors, financial services, input suppliers, transport-logistics operators, farming organizations, government sector representatives, and extension service providers. Specific interview questions are developed for each of these actors.

C.3. Adapting to the Local Context

For fieldwork, it is important to understand and adapt to local contexts. It is advisable to hold separate focus group discussions (FGDs) for different gender groupings, age groups, or ethnicities to capture the opinions of all relevant actor groups. During primary data collection, the AT should consider cultural constraints that may reduce access to and the quality of data about the peculiar circumstances of women. Due to women's and girls' potentially different risk exposure, impacts, and responses, the risk analysis in sections 2.1 and 2.2 must consider gender-related disparities by using gender-differentiated datasets and interviewing gender-differentiated groups of AVC actors about their risk perception. During fieldwork, conducting separate interviews and FGDs with groups of women can create safe spaces for them to express their perceptions and experiences; it may also be beneficial to consult experts about gender dynamics among vulnerable population groups. Significant differences between men and women in particular AVC actor groups, however, may also be discovered during interviews in the field. If this is the case, these groups should be disaggregated by gender for further analysis. The AT may have to react to additional, relevant information about gender differences by interviewing additional stakeholders. Section 3.2 explains in more detail how gender-related vulnerability can be measured.

Depending on the number of actors in the various AVC actor groups, different approaches can be appropriate. In many cases, the AVC production stage involves the largest number of actors. To increase the reliability of fieldwork results, we recommend utilizing focus group discussions (FGDs) – for example, by running 10 FGDs. This allows for the collecting more balanced information about producers' average exposure to risks or their capacity to manage them than individual interviews. Depending on the local context, the optimal approach will be the one that enables the AT to obtain a reasonable sample of answers across all groups of AVC actors. Further down the value chain, fewer actors are involved, so fewer interviews are needed.

In addition, traveling to important trading points at the time of maximum activity makes it easier to engage relevant actors and creates opportunities for unexpected exchanges with additional actors or observers. The AT should also account for additional costs in cash for running the interviews to cover using the interviewees' precious time at the trading spot. Interview results are of particular importance to identify risks, estimate their impacts on AVC actor groups, assess actors' capacity to manage these risks, and pinpoint solutions that strengthen their capacity. Yet it is important to take account of ethics in these meetings, as identified above.

C.4. Insights Provided Through Interviews

Fieldwork will shed light on questions at the heart of the AVC-RAS because it:

1. verifies the actors' assumed roles and relationships in the AVC.
2. identifies further risks not found in the literature review.
3. validates risks derived from the literature review.
4. assesses the frequency and impact of these risks from the actors' perspective.
5. evaluates the capacity of stakeholders to manage these risks.
6. pinpoints gaps in risk management instruments, opening opportunities for improvement.

Assessing the probability and impacts of historical risk events through interviews entails obvious constraints such as a lack of objectivity and the limitations of memory. The frequency and severity of recent, easily remembered events is overemphasized, while we often forget and ignore older, unpleasant memories (Kendrick, 2012). Therefore, it is important to use quantitative data where possible, and clearly state the sources and reliability of information in the AVC-RAS. Information gained through literature review and data analysis can validate interview results, reducing their subjective bias. For interviews with AVC producers, the AT can bring the results from data analyses to the interviews and validate them with the interviewees. This step is not necessary if the actor groups provide their own statistics and figures.

Finally, in the last two weeks of the study, the AT will consult a range of experts to finalize the action plan. This activity needs to be tailored to the specific suggested solutions in the action plan. These interviews provide specific advice and estimate costs and benefits of implementing prioritized ARM solutions. They may involve researchers, development practitioners, donor and government representatives, or specialists and consultants from the private sector.

Annex D: Risk Assessment in detail

PHASE 02
RISK ASSESSMENT

Assessing risks is the core activity of this toolkit. The key elements of a risk assessment are estimating the probability and impact of a risk event. This helps structuring available information about a risk. Understanding a risk's probability and impact is the basis for a prioritization of risks and a definition of an appropriate action plan to address them. This Annex describes approaches presented in the main document in more detail and will lead to an assessment of probability and impact of risks.

Content

The Excel Spreadsheet in Annex I can be used for better organizing and interpreting collected and analyzed information, and calculating risk scores, capacity to manage risk scores and vulnerability indices. Its use is explained in the following sections.

D.1. Risk identification

This section corresponds to section 2.1 of the main document.

Step 1 – Collecting Information

The AT starts the risk assessment by reviewing literature to identify the main risks for the AVC. The literature to be reviewed includes scientific publications, analytical reports and selected gray literature. Because the units of analysis are the AVC actor groups, the AT identifies relevant risk events for each actor group if information is available. Depending on the results of the research, the units of analysis may be further split, e.g., by gender. This study only considers covariate risks with significant effects on the value chain or whole group of actors; risk events affecting individual farms are beyond its scope. The geographical scale considered should be appropriate to the scale of each AVC and the location of its actor groups. The AT's literature review focuses on identifying risks in the selected AVCs while learning about their causes and effects. This means that the corresponding crops' characteristics and actors involved in the AVCs at different stages along the supply chain, at varying scales, and affecting different groups in the AVCs need to be studied. Examples of risk events and their high-level impacts for various risk categories along the AVC can be found in Table D.1. This review is also a good means of preparing for the field work where focus group discussions and interviews with the various actors along the AVC will be performed.

While the literature review is basis enough to move on to composing a list of risks, information collection continues through fieldwork, where additional risks are being identified that are relevant to the AVC actor groups and should be added to the list of relevant risks. Interviewees should validate whether the draft list of risks for each AVC actor group is accurate. Each AVC actor group must be represented and asked about their perceptions of risk exposure – including gender-differentiated groups. Questionnaires to support this step can be found in Annex H.

Table D.1. Examples of risks impacting AVC actor groups (adapted from Jaffee et al. 2010).

Potential impacts on AVC actor groups					
Input Suppliers	**Producers**	**Farm Gate Collectors**	**Processors**	**Traders**	**Distributors**
Weather-related risks					
Demand for inputs Repayment for inputs on credit	Planting decisions Input use Yield and quality, income decline	Availability, price, quality of products logistic costs	Availability, price, quality of products logistic costs	Availability, price, quality of products logistic costs	Availability, price, quality of products logistic costs

(...)

(...)

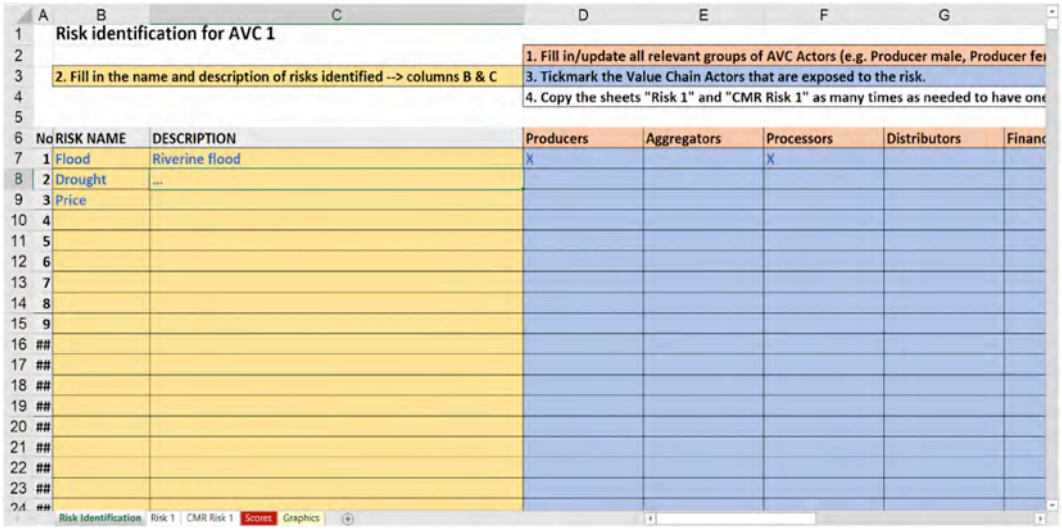
Input Suppliers	Producers	Farm Gate Collectors	Processors	Traders	Distributors
Natural disasters					
Demand for inputs Repayment for inputs on credit	Yield, quality Farm asset loss Longer-term output and income decline	Availability, price, quality of products logistic costs	Availability, price, quality of products logistic costs; Alternative supply sources	Availability, price, quality of products logistic costs Loss of market contracts	Availability, price, quality of products logistic costs alternative supply sources
Biological and environmental risks					
Demand for inputs Repayment for inputs on credit	Input use yield, quality and income decline Production costs	Availability, price, quality of products logistic costs Need to screen or test supplies	Availability, price, quality, safety of products Brand reputation Lost market access	Availability, price, quality of products Brand reputation Lost market access	Availability, price, quality of products Brand reputation Product liability Need to procure from alternative sources
Market-related risks					
Demand for inputs Repayment for inputs on credit	Planting decisions Input use Yield and quality, income	Availability, price, quality of products	Availability, price, quality of products	Availability, price, quality of products	Availability, price, quality of products
Policy and institutional risks					
Demand for inputs Repayment for inputs on credit	Planting decisions Input use Yield and quality Ability to sell	Availability, price, quality of products Operating cots Ability to intermediate	Availability, price, quality of products Availability, price, quality of other products; Need to procure from alternative sources; Operating costs	Availability, price, quality of products Need to procure from alternative sources Operating costs Ability to sell	Availability, price, quality of products Need to procure from alternative sources Operating costs
Logistics-related risks					
Demand for inputs in current and subsequent year (or season)	Input access and use Yield and quality Postharvest losses Income decline	Availability, price, quality of products Availability and price of other products Operating costs	Availability, price, quality of products Availability and price of other products Operating costs	Availability, price, quality of products Availability and price of other products Operating costs	Availability, price, quality of products Availability and price of other products Operating costs

This AVC-RAS is based on available data and experience about the AVC under analysis. It is therefore unlikely that a rare event that has never happened in the country's recorded history, also known as "black swan" event, will be identified in this AVC-RAS. Such an event is considered to be unknowable. However, based on literature, data analysis, and interviews, this study should identify "gray swans", which are rare events that are known threats, although their severity and probability of occurrence are unknown (Hole & Netland, 2010).

Step 2 – Composing a list of risks

The list of risks can be entered into the spreadsheet template in Annex I, sheet "Risk identification" (Figure D.1). The excel sheet can be used to summarize the list of risks, marking the AVC actor groups that are affected by each risk. This overview will help the Assessment Team structure the analysis. During the field work, the long list should be continuously adjusted, considering additional information gained from interviews.

Figure D.1. Screenshot of Excel Template, sheet "Risk Identification".



Step 3 – Timeline of risk events

Based on the basis of the literature review, the Assessment Team creates a timeline of significant historical risk events affecting the AVC. Figure 2.3 in the main document features an example at the sectoral level. If data is available, a similar timeline could be created for different geographical areas, actor groups or agricultural value chains.

D.2. Risk analysis

The risk analysis is introduced in the main document in section 2.2. The Assessment Team can conduct the following five steps to perform the analysis:

Step 1: Analyzing effects on the AVC
Step 2: Analyzing selected risks in more depth
Step 3: Assessing correlations
Step 4: Closing gaps through interviews
Step 5: Estimating probability and impact

The following methodologies are not exhaustive. Depending on the type of risks being quantified, the availability of data, time and skills available for this study, alternative methodologies may be better suited to a specific context. Considering the tight timeframe of the AVC-RAS, the majority of estimations might be based on the statements of AVC actors and key informants and on the literature, rather than on analysis.

Step 1 – Analyzing effects on the AVC

In a first step, the AT analyzes available datasets and identifies historical dates when the AVC was affected by a risk, causing disruptions, fluctuations in production or yield, or price shocks. If the data permits it, such analyses should be performed for each AVC actor group separately and disaggregated by factors such as gender and geography. Relevant variables measure the performance of the AVC, such as yield, production, income, and trade data. Potentially useful datasets are summarized in Annex B.6. The estimation of the most important factors: probability and impact of each risk, are described below. Then, an example of a time series analysis is described which is the most common analysis performed with historical data. These analyses yield pertinent information about frequency, fluctuations, and losses.

Assessing probability

The probability or likelihood of the occurrence of an identified risk event can be assessed and quantified by one of the following three options (ISO/IEC, 2009).

1) If time series data is available, this is the method that is used in most cases. Historical data is analyzed to extrapolate a risk's occurrence to the future. Probabilities derived through this method, however, are uncertain if a hazard event historically occurred with very low or zero frequency. Another weakness of this approach is that it assumes that the hazard's characteristics do not change over time. The frequency is calculated as the number of occurrences of a particular risk event within a specified time period. In the following formula for frequency, T represents the average time interval between two consecutive risk events.

$$f = \frac{1}{T}$$

This approach is explained with an example below.

2) Expert opinion can offer an estimation of the probability that a specific risk event will occur or provide a basis for the estimation.

3) Predictive techniques are methods based on an analysis of systems, facilities, equipment, and other relevant components. They typically involve simulation models that fall beyond the scope of a rapid AVC-RAS.

Measurements of the probability of different risks can vary due to uneven data availability. However, we recommend using the same definition of the probability of occurrence for all risks in the same way. The probability of occurrence can be defined as the likelihood of an event occurring per year using the frequency formula – e.g., 0.5 for an event that happens every second year. It can also be defined as the average interval between consecutive risk events occurring – in this example, 2 years.

Assessing impact

The impact is the adverse effect a risk can have on the agricultural value chain. Depending on the objectives defined by the client, impact can be defined as a production loss, food insecurity, or other criteria. When a risk is having a high impact on an AVC, its effect or damage is more severe than that of a risk with low impact.

Methodologies to quantify and estimate the value of impact for each identified risk can range from simple calculations of variations from a mean to using sophisticated models and software, such as the ones used by the insurance industry. The choice of adequate assessment techniques is dependent on the risks identified, and also on the following factors (ISO/IEC, 2009): the skills and capacity of the AT, constraints on time and other resources, and the budget available for the study. Whatever methodology is chosen, it is essential to apply the same approach to all selected commodities, allowing comparisons of the relative importance of risks.

For the assessing impact, datasets that measure an AVC's performance are relevant. The following section presents an example of a time series analysis to identify probability and impact of production risks.

Example of a time series analysis

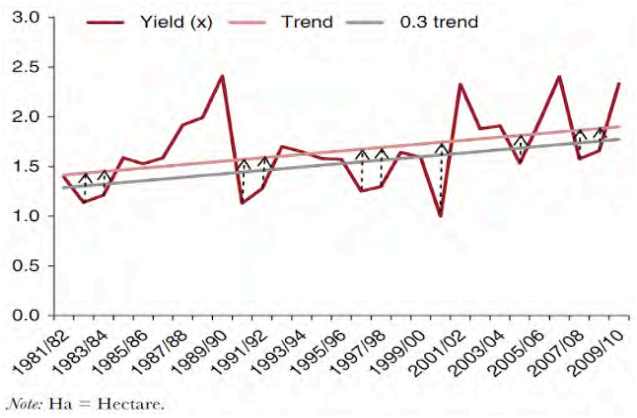
Time series analysis is the most common methodology for risk assessments. For this, historical time series of data is required measuring the occurrence of the hazard event (e.g., rainfall data) or its effect on the value chain (e.g., yield data). The longer the time series are, the more reliable statistical analysis normally get. However, the required minimum number of years depends very much on the risk's characteristics. For climate events, traditionally, a time series of 30 years was considered as sufficient. However, recent studies about predicting climate events have shown that different climate variables require different observation periods. In many cases, an analysis of the most recent five to ten years of a dataset is as good for prediction as a 30-year period of data (WMO, 2018).

Example of defining probability and impact of production risks (World Bank, 2016).
Depending on the risk being analyzed, the standard deviation can be used as a criterion for measuring the hazard's impact. This section contains step-by-step instructions for performing time series analysis of yield losses or production losses and probability. These instructions can also be applied to other datasets such as price, weather, or consumption data to calculate their volatility. The analysis of production or yield data can be utilized to calculate the monetary losses caused by production risks such as weather-related, biological, or environmental risks. Unlike yield data, production data includes not only changes in yield but also area cultivated. It is crucial to use the same type of data and methodology for all risks and commodities in order to be able to compare them later.

1. The AT obtains time series data for yields relevant to the AVC. Potential sources are in-country data or the FAOSTAT database from the Food and Agriculture Organization of the United Nations (FAO).
2. The AT calculates the linear trend for yields by applying ordinary least squares (OLS) and associated predictive values. The trend line represents the expected value of yields with no volatility.
3. Next, the AT computes the standard deviation (SD) for the linear trend.
4. To define a threshold that helps identify risk events, the trend value is reduced by one third of the SD. Every year that shows a variation below one third of the SD is considered as characterized by normal volatility, the cost of doing business. Every year that shows variation above the third of the SD is considered as a year that a risk event occurred. The threshold of 0.3 of the SD is based on trial and error (World Bank, 2016), to highlight the years when yields dropped significantly because a risk was realized. Depending on the vulnerability of the AVC, a different threshold might be appropriate. We recommend trying this threshold and comparing the results with other sources of information about the historical occurrences of risk events. If registered historical events are not identified, the threshold needs to be adjusted.
5. Those years when yields fall below the threshold can be marked as "loss" years.
6. For "loss" years when the absolute value of the deviation from the trend line is larger than the threshold, the yield loss can be calculated by deducting the yield value from the trend line value.
7. The total quantity of output loss is calculated by multiplying the yield loss by the total area harvested in that particular year.
8. Then, the AT obtains the yearly prices of the commodity and converts them from nominal to constant values using the local currency.
9. The total output loss is then multiplied by the constant price in order to compute the value loss for each year with a loss expressed in local currency.

10. From these losses in the time series under study, the following indicators are calculated:
    - **average loss** is found by dividing the sum of the value losses for years below the threshold by the number of years characterized by a loss below the threshold in the series.
    - **annual average loss** is calculated by dividing the sum of the value losses for years below the threshold by the total number of years in the series.
    - **maximum loss** is identified by taking the value loss of the year with the highest loss.
    - **probability of occurrence** is calculated by dividing the amount of "loss" by the total number of years with data.

BOX D.1. Paddy rice yield losses in Tanzania (t/ha).



Note: Ha = Hectare.

1. The dark red line shows the variations in yields over time, tracing Tanzania's historical records of the rice yields in tons per hectare from 1981/82 agricultural cycle to 2009/10.
2. The straight, light red line shows the linear trend of yield over time, which is the expected yield in the absence of volatility. Investment decisions are often made based on the trend line value.
3. The gray line represents the threshold below which we assume risk events have occurred, and one-third of a standard deviation, was used. The threshold could also be defined differently, as long as it captures major declines in yield that pose a significant loss to producers and is used consistently for all commodities.
4. Any yield below the threshold is considered a loss that occurred due to a risk event. The loss in yields is calculated as the difference between the expected yield (trend) and the actual yield. In this example, there were yield losses in 10 years out of 29.
5. As a final step, the monetary value of the loss can be calculated for the loss years only, multiplying by yearly prices as described above in points 7-9.

Source: World Bank 2016

With this type of data, the frequency of a risk event can be computed by identifying the number of years with a loss and dividing it by the total number of years with data.

Box D.2. Price measures for calculating production losses.

Which values of prices should be used for defining the monetary value of production loss?

To calculate the monetary value of the production losses, the first step involves recognizing how production losses affect prices. When using prices in calculations of production losses, it is important to be conscious about the different measures that can be chosen:

- The **nominal price** is the actual, current market price in a chosen currency. It includes the effect of inflation.
- When using **constant prices or real prices**, the price of a base year is used to calculate production losses of all years under analysis. The real price involves the deflation of the series to eliminate the effect of inflation during the period (Huchet-Bourdon 2011). The real price is measured against goods and services and therefore is adjusted for inflation. It is expressing the purchasing power in a chosen base year. However, there is no general consensus on the method for deflating price time series.

To understand production losses, we recommend using the price level of a base year to compare the losses of several years. The reason is that production shocks may affect prices in the short term, and inflation causes additional changes in prices. If current/annual prices were used for calculating production losses, a comparison between years would lead to a bias in the calculation of production losses.

When using nominal prices, relative price effects are captured, and this can be used for the analysis of joint production-price shocks. Joint production-price shocks might have a higher impact on a value chain than isolated production shocks. Both values are important for a better understanding of the magnitude of risk events (World Bank, 2016).

If the production data is incomplete, missing data can be reconstructed by using information from other sources – such as reports, news articles, or estimations from key informants with long experience in the agricultural sector – and by making justified assumptions. If no data is available, the analysis is dependent on interviews with key informants and value chain actors.

Step 2 – Analyzing selected risks in more depth

If time allows, the AT analyzes relevant risk events in more depth to understand the hazards, the causes for each effect, the magnitude of these events, and their frequency. For this, volatility analysis is key to most datasets. Examples are provided below. For the analysis of weather hazards, Annex J provides a detailed methodology that involves running a weather model through an online platform.

Examples of volatility analysis

As already shown with the example of a time series analysis above, analysis of volatility is crucial to analyzing any kind of risk. Risks can often be expressed as a deviation from an expected value if historical records are available. This section introduces the process to use the coefficient of variation to calculate volatility and derive probability and impact of a risk. Again, historical data of a variable of interest (e.g., price data, production data, weather data) is analyzed to derive the variable's volatility and then, assess probability and impact. To assess volatility, the AT will observe this variation of a variable over a defined time period in order to understand seasonal or yearly movements and identify how frequent past events involving high volatility of the variable have occurred. An accurate observation of volatility peaks and their recurrence over time would help the AT derive the likelihood of similar future episodes. We recommend analyzing differences between AVC actor groups and gender groups if gender-disaggregated data is available.

To capture and measure historical volatility, defined as past volatility obtained from historical data, this toolkit reports the most widely used and applicable measure of volatility in the literature, the Coefficient of Variation. The coefficient of variation (CV) is the ratio of the standard deviation (SD) and the mean. It is therefore a normalized version of the SD, but with the benefit that it is unit-free and therefore can be compared across variables. Calculating the CV provides a measure of variation that can also be expressed as a percentage and therefore is easy to interpret. Thus, we recommend using the CV in this analysis. For example, a CV of 20% means that the data shows a variation of 20% above or below the mean.

The CV represents a standardized measure of dispersion of a frequency or probability distribution. It is the SD as a percentage of the sample mean.

$$CV = \frac{Standard\ Deviation}{Mean} = \frac{\sigma}{\mu}$$

where:

$$\sigma = \sqrt{\frac{\sum_{t=1}^{n}(p_t - \bar{p})^2}{n}}$$

In the above formula, the dataset used is containing price values. p_t is the price value at time t and is subtracted by $\bar{p}$, the average value of the price over the period or subperiods under consideration. Again, the major advantage of using the CV as a measure of volatility is that it is unit-free, so it is easy to compare volatility among different commodities.

For identifying risk events, it is essential to avoid considering each movement of the variable as a risk event. For this, the AT should control for the presence of the following factors:

- **Trends**, defined as long-term movement of the mean variable during a period of time;
- **Seasonal effects**, defined as inter-annual cyclical fluctuations related to the nature of the commodity and risk; and
- **Cycles of variations**. Cycles are defined as other kinds of cyclical fluctuations, over longer time periods and not dependent on seasonal fluctuations.

If a movement of a variable can be expected, it is not considered as a risk event. Therefore, the AT should analyze historical data patterns to define a threshold of deviation that can be considered as exceptional.

For analyzing volatilities in a dataset, the total variability can be calculated. However, in many cases, it could make sense to use a simple moving average for the statistical analysis of the volatility (Huchet-Bourdon, 2011). A moving average is created by computing a series of averages of different subperiods – for example days, weeks, or months – of the full period. The simple moving average is calculated as the sum of datapoints over the entire period divided by the sum of the number of periods under analysis (see formula below). The simple moving average can be more relevant for the analysis of a long history of data points. The volatility measure can be computed at an annual and monthly level (Huchet-Bourdon, 2011). Depending on data availability and the specific context, the AT will choose whether to observe annual or inter-annual volatility.

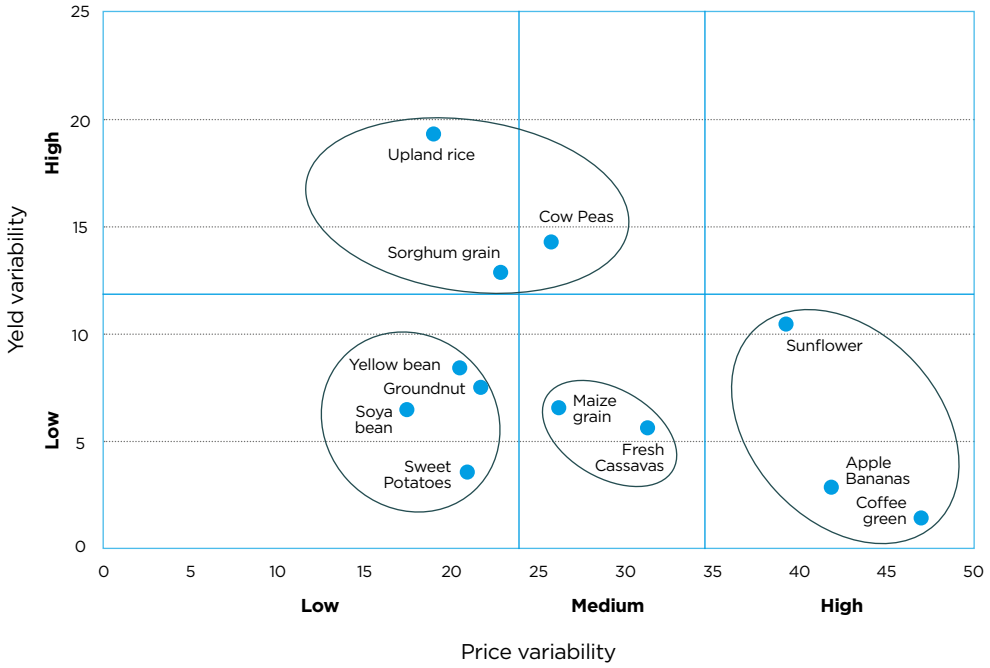
$$SImple\ Moving\ Average = \frac{(x_1 + x_2 + \ldots + x_n)}{n}$$

where: n = number of total periods and x = average of a period

Volatility analysis is used for analyzing different datasets. These methods are widely used for analyzing price risks. In addition to calculating inter-annual and annual price volatility, the following three analysis can be interesting.

1. Comparing volatility of various crops can help to understand whether the price risk of one AVC is linked to others. If all commodities are experiencing a high volatility, the market could be considered as not stable. This information can be relevant for understanding the price risk of one commodity and is a good basis for discussion with experts about potential solutions to address this risk. The risk assessment study performed in Uganda (PARM, 2015) presents a comparison of the variability in yield and price in different AVCs, which can be used for benchmarking a specific commodity (Figure D.2). The CV was used as an indicator used to measure variability of yield and price. If data is available, a calculation of the variability of revenues would help understanding the relationship and any correlation between price and yield.

Figure D.2. Yield and price variability for selected commodities in Uganda.



Source: PARM (2015)

Figure D.2 presents the variability in yields and prices of commodities in Uganda. Such an illustration can be a useful tool to summarize and document the results of a variability analysis and to assess price elasticities. It might be expected that commodities with high yield volatility would also have high price variability if the price correlates with yield supply. However, in Figure D.2, this is not the case. Commodities such as sunflowers, apples, bananas, and green coffee have a high price variability, even though these show low to medium yield volatility. These commodities are acutely exposed to price risk. Rice and sorghum, meanwhile, have high yield volatility but low-price variability, indicating a lower price elasticity for these crops. Food staples such as maize and cassava show low yield variability but medium price variability, which means that they have a higher price risk than soya, yellow beans, groundnuts, or sweat potatoes.

2. The AT can compare the volatility values of subperiods with the volatility mean value of the whole period. The overall mean is a measure of how volatility has changed on average in prior years. In other words, if the measure of volatility for a specific year is similar to the historical mean, the relative price movement over that specific period cannot be considered a risk because it is to be expected. The AT should instead pay more attention to prices with higher levels of volatility relative to the whole period of study.
3. The volatility can be calculated at different levels of geographical aggregation if data is available. This can help identify local patterns and increase geographical granularity in relation to a price risk (OECD, 2011).

Step 3 – Assessing correlations

When investigating the consequences of specific risks, the AT may discover correlations with other risks and transmissions between AVC actors. If the variability of one variable systematically increases or decreases the variability of another variable at the same time or with some time lag, this is called a correlation. Such correlations can have a cumulative or an offsetting effect on the value chain and therefore should be considered for estimating the impact of a risk. For example, for producers, a large-scale risk event can reduce the yield; however, due to lower supply, prices could increase. These increased prices can offset some of the risk's negative impact for producers. If datasets are available, correlations can be calculated. The AT can perform correlation analyses of different risk variables. Examples of interesting analyses include the correlations of the following variables: yield and prices, input prices and output prices, input prices and yields, prices of different commodities, and domestic prices and international prices. Based on knowledge on the AVC that was already collected in previous steps, an appropriate analysis can be selected. An example was already provided with Figure D.2, which could be complemented with the variability of revenue to identify correlations between yield and price.

Step 4 – Closing gaps through interviews

The results of steps 1 to 3 will be the basis for interviews with key informants and actor groups along the AVC. From these interviews, the AT will learn more about the perceptions of AVC actor groups about their risk exposure, the impacts of these risks on their business and income, their frequency, and their causes (details in Annex C). On the basis of these interviews, the AT can verify and round out analysis results.

Step 5 – Estimating probability and impact

From gained information, the AT needs to estimate frequency, average loss, annual average loss, and maximum loss for each relevant risk and AVC actor group. In many cases, the estimations are not exact, quantitative calculations since this would go beyond the scope of this exercise. Estimations based on relevant information are sufficient to compare the impacts of various risks on the AVC and later prioritize appropriate responses.

The AT can utilize the CV, given as a percentage, as measure of volatility, and provide a general threshold to define the risk events. This can entail differentiating between small and large shocks. In the assessment of Uganda's price risk for example, price volatilities between 10% and 30% are considered as small shocks, and thus less severe. Only if the commodity price volatility reaches or exceeds 30%, the event is considered a large and more severe shock (PARM, 2015). Small shocks are typically more frequent than large shocks. For this reason, their frequency can be computed from the average number of months between two consecutive shocks. On the other hand, the frequency of large shocks, due to their rarer occurrence, is measured as the average number of years between two consecutive shocks, using the formula for frequency above. The assessment team might decide to focus on the

analysis of large shocks only. These thresholds for the definition of small or large shocks should be discussed and refined on the basis of the local context and expert judgments. The probability of occurrence typically is the calculated frequency of a shock. Expert interviews could be used to validate the result.

Estimating impact depends on the availability of data and the risk that is being analyzed. If production or revenue data is available, historical shocks can be identified and a monetary value can be derived for these shocks, using constant prices. An example how to calculate the impact of production risks is provided in the example of the time series analysis (see Step 1 of this section). The risk assessment performed for PARM in Uganda provides an example for the calculation of the monetary value of price shocks (PARM, 2015). In most cases, data is not sufficient, and expert judgements are needed to define a value of average loss, average annual loss and maximum loss for an entire AVC, and for its AVC actor groups in particular. For this, the results of the field work will provide valuable information about a risk's impact.

D.3. Risk scoring

This process stage is introduced in the main document in section 2.3. It requires the Assessment Team to define and apply a methodology to compare the risks identified for a later prioritization. Additional explanations can be found in the following three steps.

Step 1: Synthesis of risk analysis
Step 2: Defining the risk scoring framework
Step 3: Calculating the total risk score

Step 1 – Synthesis of risk analysis

The AT synthesizes the results of the risk assessment. It is crucial for the later risk scoring that the following variables are clearly understood and assessed for each risk and AVC actor (if possible):

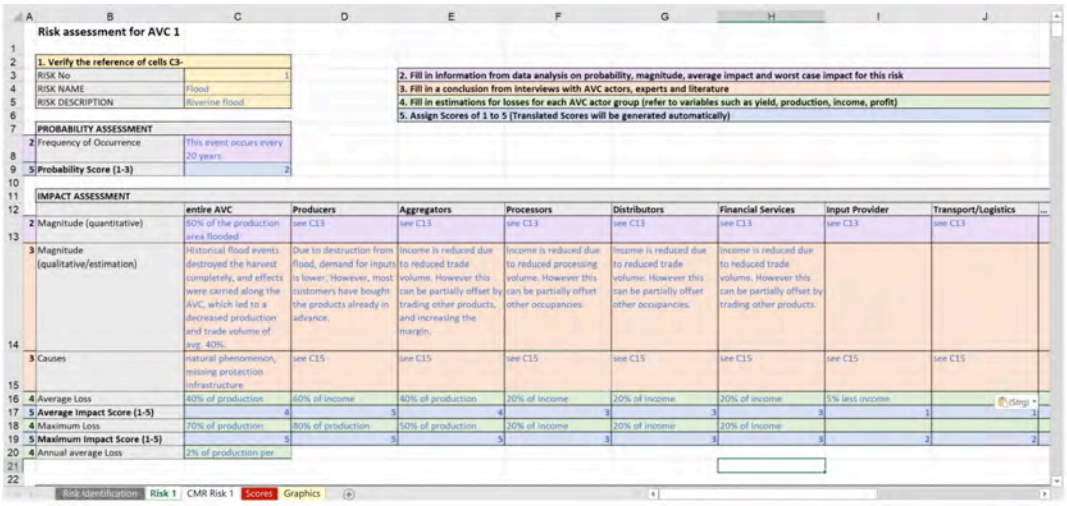
- Frequency: the estimated frequency at which a risk event occurs.
- Average loss: the estimated average loss in production or income in those years when a risk event occurs.
- Maximum loss: the estimated loss in production or income in the year with the highest loss from a risk event.
- Average annual loss: the annual expected average loss in production or income from a risk event.

For each risk, AVC, and actor group, the conclusions can be entered into the spreadsheet entitled "Risk 1" in the template in Annex I (see also Figure D.3). The spreadsheet includes instructions about how to use it. For each risk, AVC, and actor group, the AT fills in estimations of frequency, magnitude, causes, and losses into the purple and red cells of the corresponding spreadsheet. Then, the estimations for average loss, maximum loss and average annual loss can be entered into the green cells.

The example in Figure D.3 is just illustrative and shows the results of a flood risk assessment. The flood risk event is expected to occur every 20 years (cell C8). Information of the flood event's magnitude can be found in lines 13 and 14. The flood event historically affected on average 60% of the production area and led to a reduction of the overall AVC production by 40% (cell C16). The effect on producers' loss is with an average loss of 60% higher than the one for the entire AVC because they often have already purchased inputs which adversely affects their balance sheets. Aggregators are affected by an average loss of 40% while other actors show lower amounts of losses of 20% or less. Line 18 in the spreadsheet shows the historical maximum loss which is a production loss of 70% for the entire AVC. The annual average loss in cell C20 can be calculated by dividing the average loss by the frequency, here 40% divided by 20 for the flood event happening every 20 years. This leads to an annual average loss of 2% of production loss to this type of flood event.

The results of the risk analysis form a basis to score the risks as described below in step 3 of this section.

Figure D.3. Screenshot of spreadsheet template.



Step 2 – Defining the risk scoring framework

Risk scoring should be based on the objectives of the AVC-RAS and criteria should be defined by the stakeholders in workshop 1 (see Annex A). The proposed risk scoring framework foresees five categories of impact: 1=negligible, 2=moderate, 3=considerable, 4=critical, 5=catastrophic. It also involves three categories of probability: 1=occasional, 2=probable, 3=highly probable. The stakeholders are asked to define criteria that are used to assess a risk event's impact as e.g., catastrophic, critical, etc. The criteria and categories should be established in workshop 1 through careful consideration of their relevance for this AVC-RAS, based on the study's original objectives. If fewer criteria are picked, the comparability of the scores of different risks will improve. We recommend a maximum of 4 criteria. Examples can be found in Tables 2.2 and 2.3 in the main document.

Below are examples of quantitative criteria that could be chosen for the impact scoring categories.

- Percentage of reduction in AVC production or AVC actors' income (World Bank, 2016)
- Percentage of the AVC actors that experience significant income losses
- Percentage of the population whose food security is endangered
- Percentage of one AVC actor group who experience significant losses or disruptions, e.g., 90% of women or young farmers

Optimally, the volatility measures for market and financial risks are translated into estimations of income loss for the AVC actor groups. Otherwise, additional criteria need to be defined to score the volatility measures, such as for example a percentage of decrease in output price.

The following are qualitative criteria that could be used for scoring (Gaonkar and Viswanadham 2004).

- **Deviations**: Fluctuations in key factors such as supply, costs, demand, and logistics can lead to underperformance of the value chain, but do not result in changes to the underlying value chain structure. Information about deviations is based on qualitative statements, e.g., by key informants, not on data analysis.
- Disruptions: Critical hazards can cause the non-availability of certain value chain links such as production, processing, marketing, or distribution facilities, which means that changes in the structure of the value chain are necessary.
- **Shutdowns**: Catastrophic hazards can lead to the temporary and/or permanent shutdown of parts or all of the value chain.

The AT should define the criteria and thresholds of these categories based on the study's objectives, the local context, the selected AVC, and discussion in the steering panel meeting.

Step 3 – Calculating the total risk score

This step is a critical activity in the risk analysis. The following steps guide the AT through the scoring exercise:

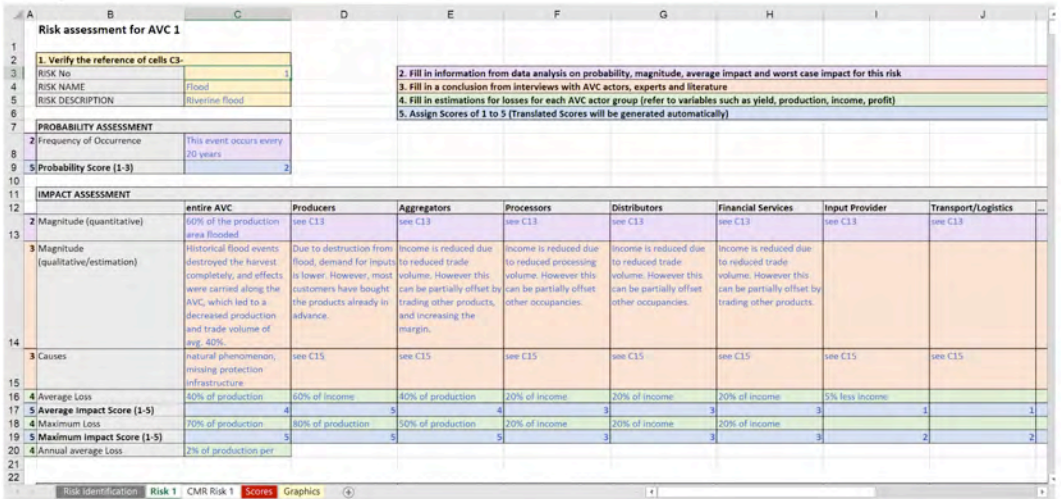
1. For each risk, the quantitative and qualitative estimations of frequency and losses for each AVC actor and the entire AVC comprise the basis of risk scoring. At this point of the analysis, this information will already have been gathered through literature review, data analysis, and fieldwork. From the synthesis, the following variables should be available: frequency, average loss, maximum loss and average annual loss.
2. By applying the risk scoring framework defined in step 2, required scores can be derived. The AT needs to derive the following scores for each actor and risk:
   - Probability score
   - Average impact score
   - Maximum impact score

Based on the example of Table 2.1 in the main document, a score of 1 to 5 will apply for average impact and maximum impact scores, whereas a score of 1 to 3 will apply for the probability score (Table 2.2). Whenever one of the criteria of a category of probability or impact is met, the risk will be attributed to the corresponding category and receives the corresponding probability score of 1-3 (1=occasional, 3=highly probable) or impact score of 1-5 (1=negligible, 5=catastrophic). If the data pertaining to one risk corresponds to multiple categories, the highest-rated category is selected. For assigning the right score, the AT refers to the information gathered for each risk through previous process steps:

- The probability score is derived from information about a risk's frequency.
- The average impact score is derived from the average loss.
- The maximum impact score is based on the maximum loss, applying the same scoring categories as for the average impact.

3. The annual average loss is not needed for the risk score but will be of relevance later to justify the action plan and corresponding investments.
4. These probability and impact scores can be entered into the blue cells of the sheet entitled "Risk 1" in the spreadsheet template in Annex I (see Figure D.4). These values are the basis for assigning the risk score.

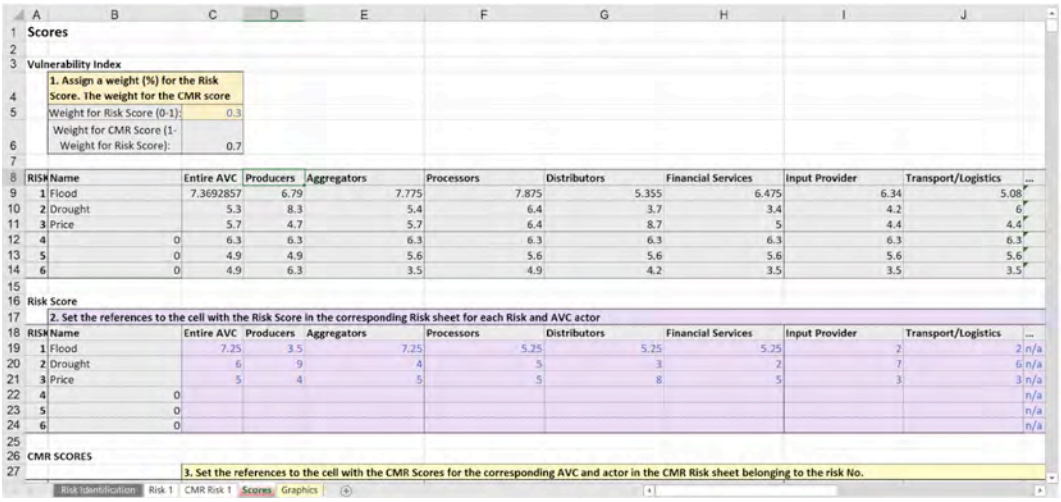
Figure D.4. Example of probability and impact scores entered into spreadsheet (blue cells).



5. The AT can assign probability and impact scores based on their own professional judgment about available data. Some risks' impacts might be difficult to assign to specific categories due to a lack of data or the complexity of the risk. Time permitting, a consultation with experts can be useful in categorizing such risks. Through on-site interviews or a virtual meeting, time permitting, a few relevant experts on the AVC or specific AVC links can validate the final scores. To facilitate this process beforehand, the AT will share a list of risks along with corresponding information about their probability, magnitude, impact, and root causes, as well as the scores for each risk and the table of scoring categories. Such consultations enable a correction of estimations based on additional inputs from experts.

6. The risk score is expressed as a function of the probability and average impact plus a consideration of the maximum loss impact. Utilizing the spreadsheet template in Annex I, the AT will draw on the scores for probability, average impact, and maximum loss impact to calculate the risk score for each risk for every AVC actor group or for the entire AVC. In order to do so, the AT needs to set references in the sheet entitled "Scores" to the corresponding risk sheets, as in the example provided wherein "Risk 1" is flooding (Figure D.5).

Figure D.5. A screenshot of the sheet entitled "Scores" in the spreadsheet template.



Scores

Vulnerability Index

1. Assign a weight (%) for the Risk Score. The weight for the CMR score

Weight for Risk Score (0-1): 0.3

Weight for CMR Score (1-Weight for Risk Score): 0.7

RISK	Name	Entire AVC	Producers	Aggregators	Processors	Distributors	Financial Services	Input Provider	Transport/Logistics	...
1	Flood	7.3692857	6.79	7.775	7.875	5.355	6.475	6.34	5.08	
2	Drought	5.3	8.3	5.4	6.4	3.7	3.4	4.2	6	
3	Price	5.7	4.7	5.7	6.4	8.7	5	4.4	4.4	
4	0	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	
5	0	4.9	4.9	5.6	5.6	5.6	5.6	5.6	5.6	
6	0	4.9	6.3	3.5	4.9	4.2	3.5	3.5	3.5	

Risk Score

2. Set the references to the cell with the Risk Score in the corresponding Risk sheet for each Risk and AVC actor

RISK	Name	Entire AVC	Producers	Aggregators	Processors	Distributors	Financial Services	Input Provider	Transport/Logistics	...
1	Flood	7.25	3.5	7.25	5.25	5.25	5.25	2	2	n/a
2	Drought	6	9	4	5	3	2	7	6	n/a
3	Price	5	4	5	5	8	5	3	3	n/a
4	0									n/a
5	0									n/a
6	0									n/a

CMR SCORES

3. Set the references to the cell with the CMR Scores for the corresponding AVC and actor in the CMR Risk sheet belonging to the risk No.

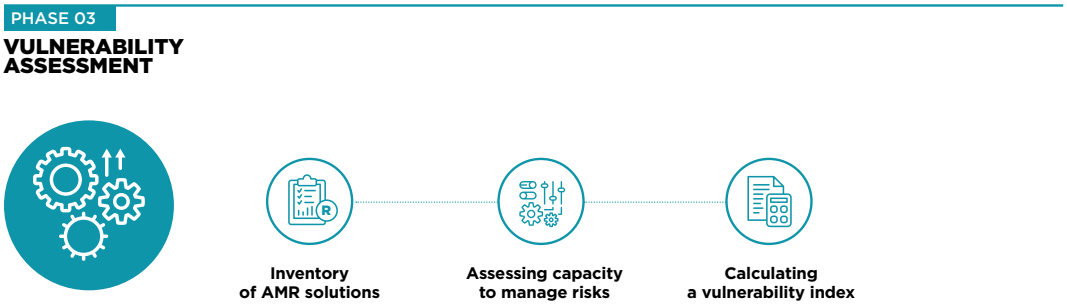
Risk Identification | Risk 1 | CMR Risk 1 | Scores | Graphics

The scores are weighted based on the following formula:

$$Risk\ Score = 0.7\ (Prob\ Score * Avg.\ Impact\ Score) + 0.3\ (Max.\ Impact\ Score)$$

The formula for the risk score allows us to calculate one single score for each risk to an AVC, and even per AVC actor group. The formula is based on the probability score, the average impact score, and the maximum impact score assigned to each risk, for each AVC and AVC actor group in previous steps. The risk score can range from 1 to 12, where 12 represents the maximum rating for a very high risk, and 1 is the lowest possible risk rating. The weight of 0.3 gives the maximum loss a relevance in the overall risk score, ensuring that risks that can have devastating effects are appropriately taken into account.

Annex E: Supporting the vulnerability assessment



The overview of the steps for calculating the Vulnerability Index are found in Chapter 3 of the main text. An integral component of the vulnerability assessment is to look at those AVC actor groups that are "doubly vulnerable" - especially women and other groups, such as youth and refugees. The second section of this Annex contains a checklist for gender, although this checklist can also be used for other vulnerable or marginalized groups.

E.1. Measuring Capacity To Manage Risk (CMR), an interview-based process

This section corresponds to sections 3.3 and 3.4 in the main document.

Methodology

The interviews, and if possible, focus group discussions, with key informants and with AVC actors provide a rating of the actor group's CMR, consisting of the following ratings (Table E.1):

- **Effectiveness rating (ER)**, which rates the effectiveness of options for each option and interviewee.
- **Accessibility or applicability rating (AR)**, which rates the capacity to access or apply options for each option and interviewee.

The ER shows the importance of respective risk management options. Therefore, the ER is used as a weight to develop an average of the AR, which is a CMR score for each cluster of options as regards risk mitigation, transfer, or coping, and for each interview. If Annex I is used to structure and organize the risk and vulnerability assessment, the AT takes the average of all interview results and enters one CMR score per cluster for each AVC actor into the corresponding cells. This is be explained further below. The synthesis of the individual interview results into a final score that is entered into the spreadsheet can also be based on professional judgment by the AT, for instance if the voice of one key informant is given more weight.

Table E.1. CMR rating table with numerical examples for drought risk.

Drought	Option	Effectiveness Rating (ER), scale 1-3	Accessibility/ Applicability Rating (AR), scale 1-4	CMR Option Score = ER*AR
Mitigation	Irrigation	3	3	9
Mitigation	Investing in varieties	2	2	4
Transfer	Insurance	3	3	9
Coping	Savings	3	4	12
Coping	Family	2	4	8
Coping	Government	1	3	3
Drought Risk CMR Score (Average)				7.5

Interviews

Preparing for the interviews: the AT should list potential and existing, relevant risk management tools and solutions to address risks that were identified for the AVC during the literature review.

Step-by-step interview process: The following approach should be reflected by the AT and alternative options and scales could be applied if appropriate. We suggest including the following questions in the interviews or FGDs with AVC actors, after they have been asked about their role in the AVC and their risk exposure. Actors should not be shown the list of solutions prepared by the AT beforehand. The following questions are posed for each risk:

1. The interviewer asks, "What are your options to address and manage the risk?" Examples might include irrigation, storage, or savings. Then, the interviewer lists the answers in a table (such as Table E.1).
2. Next, the interviewer reads through this list and asks two questions about each option the interviewee has suggested.
3. How effective is this option? Provide a rating of 1-3.

1	minor effect	at least 10% reduction or compensation of losses
2	medium effect	at least 25% reduction or compensation of losses
3	significant effect	at least 50% reduction or compensation of losses

4. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4.

1	not existent, not accessible, not applicable	The option does not exist or is not accessible or applicable.
2	expensive, difficult to access or apply	Actors have difficulties accessing or applying the option. Perhaps the option or technology involved is too expensive, or they lack the specific expertise to apply it.
3	sometimes accessible or applicable	Sometimes actors cannot afford the option.
4	accessible or applicable	Actors usually access or apply the option.

5. The interviewer asks, "Which additional options are you missing?" The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating as "inaccessible."
6. At the end of the interview, the interviewer shares the list of risk management solutions that was prepared by the AT and asks whether the interviewee finds these interesting. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating as "inaccessible."

7. The interviewer calculates the CMR scores by multiplying the ER by the AR (see formula below). This leads to CMR scores ranging from 1 to 12. The total CMR score is calculated as the average of the CMR scores across all interviews, all options for the risk and actor group under review.

$$CMR\ Score = Effectiveness\ Rating * Accessibility\ or\ Applicability\ Rating$$

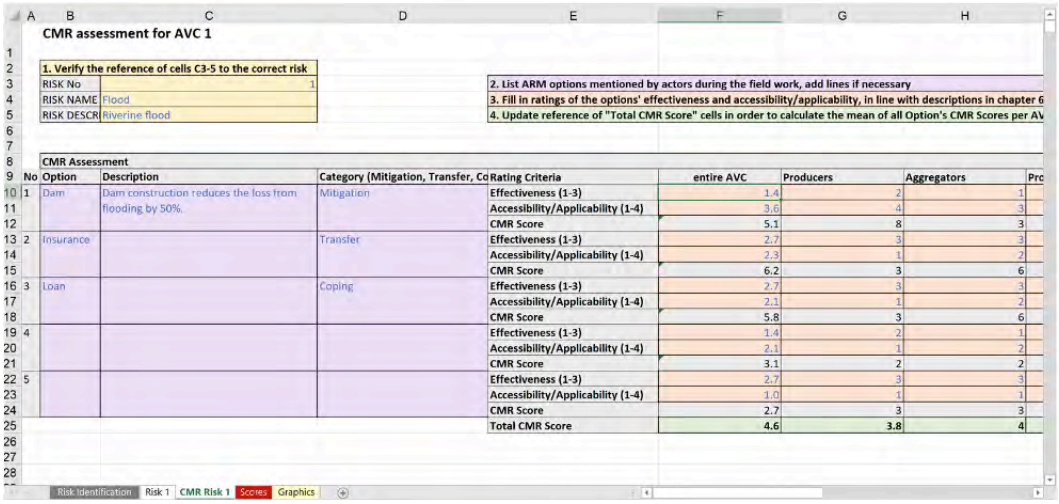
8. The interviewer performs the same interview for other identified risks.
9. The interviewer shows the CMR scores for each risk to the interviewee and discusses the ranking.

Processing interview results and calculating CMR scores

After the interviews, the AT needs to consolidate all the inputs per AVC actor group. The AT performs the following steps in the excel spreadsheet provided in Annex I.

1. As shown in Figure E.1, the options mentioned in the interviews can be listed in the purple cells B10, C10, D10 etc. The AT can assign the categories of mitigation, transfer, or coping to each of the ARM options listed during the interviews. This step may be relevant for a later gap analysis and the formulation of optimized ARM strategies for the AVC actors.
2. The ratings in terms of Effectiveness can be entered into the red cells for each AVC actor group, e.g., G10, H10 etc. Likewise, the Accessibility Rating can be entered into the next cells below. As a last step, it has to be double-checked if the green cells are referring to the right cells and provide an average of all CMR scores per AVC actor group.
3. As a result of the interviews, the AT has a CMR score for each AVC actor group and risk.
4. In order to define a CMR score for an entire AVC, either the average of all actor groups' CMR scores is computed, or the weighted average is calculated using the number of people involved in a value chain link as the weight reference. This score is also entered into Annex I, column F.

Figure E.1. Screenshot of sheet "CMR Risk X" of the spreadsheet template in Annex I.



CMR assessment for AVC 1

1. Verify the reference of cells C3-5 to the correct risk

RISK No	1
RISK NAME	Flood
RISK DESCR	Riverine flood

2. List ARM options mentioned by actors during the field work, add lines if necessary
3. Fill in ratings of the options' effectiveness and accessibility/applicability, in line with descriptions in chapter 6
4. Update reference of "Total CMR Score" cells in order to calculate the mean of all Option's CMR Scores per AV

CMR Assessment

No	Option	Description	Category (Mitigation, Transfer, Co	Rating Criteria	entire AVC	Producers	Aggregators	Prc
1	Dam	Dam construction reduces the loss from flooding by 50%.	Mitigation	Effectiveness (1-3)	1.4	2	1	
				Accessibility/Applicability (1-4)	3.6	4	3	
				CMR Score	5.1	8	3	
2	Insurance		Transfer	Effectiveness (1-3)	2.7	3	3	
				Accessibility/Applicability (1-4)	2.3	1	2	
				CMR Score	6.2	3	6	
3	Loan		Coping	Effectiveness (1-3)	2.7	3	3	
				Accessibility/Applicability (1-4)	2.1	1	2	
				CMR Score	5.8	3	6	
4				Effectiveness (1-3)	1.4	2	1	
				Accessibility/Applicability (1-4)	2.1	1	2	
				CMR Score	3.1	2	2	
5				Effectiveness (1-3)	2.7	3	3	
				Accessibility/Applicability (1-4)	1.0	1	1	
				CMR Score	2.7	3	3	
				Total CMR Score	4.6	3.8	4	

Risk Identification | Risk 1 | CMR Risk 1 | Scores | Graphics

Calculating the Vulnerability Index

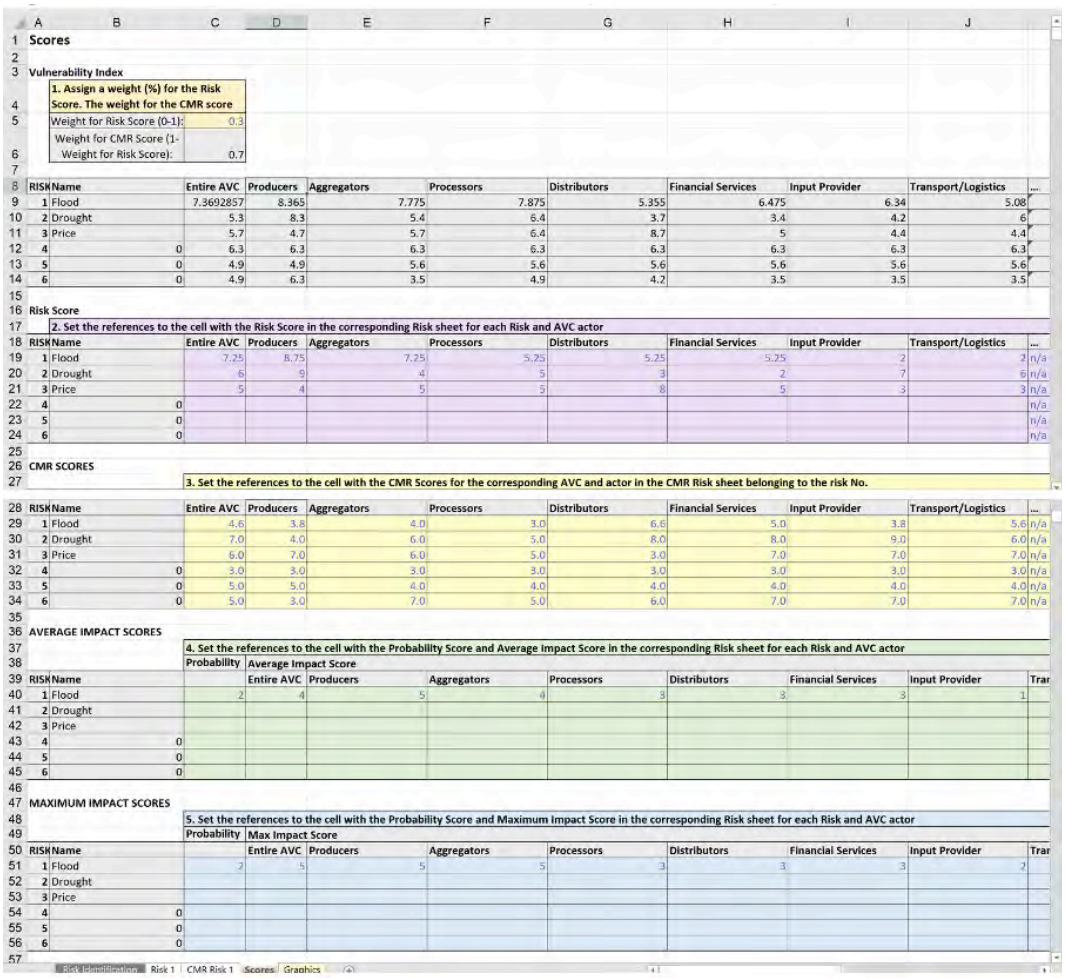
The vulnerability index (VI) can be calculated as soon as the risk scores and the CMR scores are available per risk and per AVC as well as per AVC actor group. The following activities are described in reference to the spreadsheet that can be found in Annex I.

1. The following information is required:
   a. "Risk" sheets for each risk identified, with risk scores for the AVC as well as for each AVC actor group.
   b. "CMR Risk" sheets for each risk identified, with CMR scores for each AVC and AVC actor group.
2. To compute the VI, the AT uses the "Scores" sheet, wherein references are set to the corresponding "Risk" and "CMR Risk" sheets in order to populate the tables with risk scores and CMR scores. If the risk of risks is longer, the corresponding cells need to be copied and inserted to capture all data.
3. The table for VI should then be automatically populated using the formula provided below. The following example shows an equation using the 30/70 ratio for the computation of VI. The weight of the risk score (here 0.3) should be entered into cell C5 of the sheet entitled "Scores". The weight of the risk score will have been defined by the steering panel or will be based on professional judgment. The weight can differ from the 30/70 ratio. As soon as all the scores are referred to in this sheet, the vulnerability indices can be calculated by applying the formula.

$$\textit{Vulnerability Index (VI)} = (\textit{Risk Score} * 0.3) + ((12 - \textit{CMR Score}) * 0.7)$$

4. The result is a table that shows the calculated VI, ranging from 1 to 12, for each risk, AVC, and AVC actor group (Figure E.2). This table forms the basis of the prioritization exercise. The VI must be calculated for each AVC, AVC actor, and risk. For this step, the spreadsheet template in Annex I can be used to perform calculations. The values of the VI form the basis of risk mapping and prioritization, as described hereafter.

Figure E.2. Screenshot of sheet "Scores" of the spreadsheet template in Annex I.



Scores

Vulnerability Index

1. Assign a weight (%) for the Risk Score. The weight for the CMR score

Weight for Risk Score (0-1): 0.3

Weight for CMR Score (1-Weight for Risk Score): 0.7

RISK	Name	Entire AVC	Producers	Aggregators	Processors	Distributors	Financial Services	Input Provider	Transport/Logistics	...
1	Flood	7.3692857	8.365	7.775	7.875	5.355	6.475	6.34	5.08	
2	Drought	5.3	8.3	5.4	6.4	3.7	3.4	4.2	6	
3	Price	5.7	4.7	5.7	6.4	8.7	5	4.4	4.4	
4	0	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	
5	0	4.9	4.9	5.6	5.6	5.6	5.6	5.6	5.6	
6	0	4.9	6.3	3.5	4.9	4.2	3.5	3.5	3.5	

Risk Score

2. Set the references to the cell with the Risk Score in the corresponding Risk sheet for each Risk and AVC actor

RISK	Name	Entire AVC	Producers	Aggregators	Processors	Distributors	Financial Services	Input Provider	Transport/Logistics	...
1	Flood	7.25	8.75	7.25	5.25	5.25	5.25	2	2	n/a
2	Drought	6	9	4	5	3	2	7	6	n/a
3	Price	5	4	5	5	8	5	3	3	n/a
4	0									n/a
5	0									n/a
6	0									n/a

CMR SCORES

3. Set the references to the cell with the CMR Scores for the corresponding AVC and actor in the CMR Risk sheet belonging to the risk No.

RISK	Name	Entire AVC	Producers	Aggregators	Processors	Distributors	Financial Services	Input Provider	Transport/Logistics	...
1	Flood	4.6	3.8	4.0	3.0	6.6	5.0	3.8	5.6	n/a
2	Drought	7.0	4.0	6.0	5.0	8.0	8.0	9.0	6.0	n/a
3	Price	6.0	7.0	6.0	5.0	3.0	7.0	7.0	7.0	n/a
4	0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	n/a
5	0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	n/a
6	0	5.0	3.0	7.0	5.0	6.0	7.0	7.0	7.0	n/a

AVERAGE IMPACT SCORES

4. Set the references to the cell with the Probability Score and Average Impact Score in the corresponding Risk sheet for each Risk and AVC actor

		Probability	Average Impact Score						
RISK	Name		Entire AVC	Producers	Aggregators	Processors	Distributors	Financial Services	Input Provider	Trar
1	Flood	2	4	5	4	3	3	3	1	
2	Drought									
3	Price									
4	0									
5	0									
6	0									

MAXIMUM IMPACT SCORES

5. Set the references to the cell with the Probability Score and Maximum Impact Score in the corresponding Risk sheet for each Risk and AVC actor

		Probability	Max Impact Score						
RISK	Name		Entire AVC	Producers	Aggregators	Processors	Distributors	Financial Services	Input Provider	Trar
1	Flood	2	5	5	5	3	3	3	2	
2	Drought									
3	Price									
4	0									
5	0									
6	0									

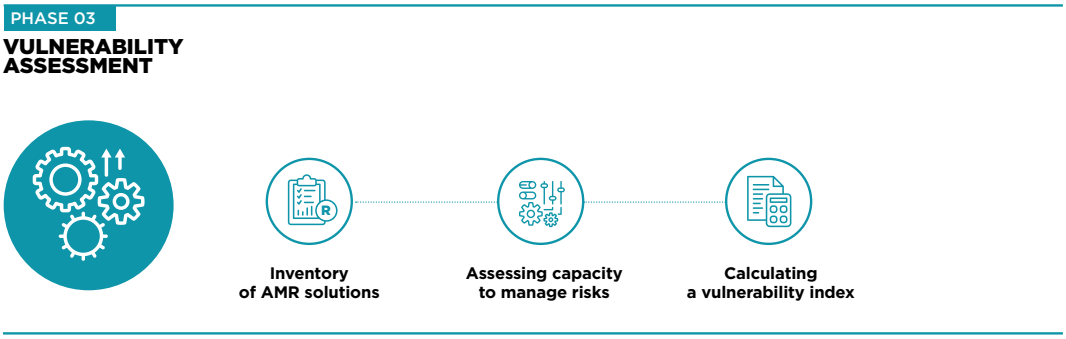
Set Identification | Risk 1 | CMR Risk 1 | Scores | Graphics

E.2. Checklist on gender and risk

The following checklist can be consulted to ensure that the action plan is sufficiently attuned to gender-related factors (PARM, 2019b), see section 5.2 of the main document).

1. The authoring team of the resource (study, report, etc.) is balanced in terms of geography and gender;
2. The resource uses gender-informed language throughout, including male and female forms for terms describing key actors and avoids gender-blind terminology (e.g., "farmers");
3. The authoring team's expertise on gender issues can be confirmed;
4. Data collection tools are gender-informed, and the resource points out gaps in gender-disaggregated data and gender-informed data, such as gender-specific indicators and gender statistics;
5. The resource takes into account information and literature on gender issues, as well as relevant instruments or policies, listing them in the resources section;
6. Expectations about gender integration in the design and implementation are stated explicitly;
7. There is a specific section about gender differences that summarizes or highlights the gender-informed analysis, findings, results, factors, conclusions, and recommendations;
8. Gender differences are reflected in every section, for example in the context analysis, design, operational plan, recommendations, etc.;
9. The stakeholder analysis takes into account gender-specific vulnerabilities;
10. The data collection and fact-finding process has been carried out in an inclusive, balanced, and participatory manner;
11. The resource reflects how the findings contained therein can be shared with men and women;
12. The resource does not reinforce or reproduce gender stereotypes, for example by depicting men or women in gender normative roles or stating - and failing to reflect on - gender-biased assumptions;
13. The reports concerning tools and training activities prove to be gender-balanced, applying a gender lens to the activities' outcomes and achievements.

Annex F – Risk mapping



This annex gives additional information on risk mapping as a basis for prioritizing risks. It corresponds to section 4.1. Information about the Prioritizing Workshop can be found in Annex A.

The main document briefly describes a set of useful questions for risk mapping that serve as examples for discussion, recognizing that the AT may add or delete questions as appropriate:

Risks Identified

1. What is the risk profile of an entire AVC or a particular AVC actor group? Which risks is the AVC exposed to and what is its capacity to manage them?
2. Which AVC actor groups are affected by a particular risk and what is their capacity to handle it?
3. What is the annual average loss associated with each risk for each AVC?

Actors' Capacity to Manage Risks

4. Which risks do AVC actors have the lowest capacity to manage?
5. Which AVC actors have access to effective ARM tools to manage a particular risk, and which show a gap?

Vulnerability indices

6. Which AVCs show the highest vulnerability indices, and for which risks?
7. Which AVC actors are the most vulnerable to which risks in the selected AVC(s)?

These questions help guide the AT to have an overview of the risk analysis results, the results of the capacities to manage risks analysis, and the vulnerability indices which combines risk and CMR scores. Based on this overview, a selection of risks or AVC actor groups should be made for each AVC for which further details are needed. The following paragraphs reflect each of the questions and provide an example which visualization could be used to support the decision process.

Question 1: What is the risk profile of an AVC or a particular AVC actor group? To which risks is it exposed, and what is its capacity to manage them?

Understanding the risk profile of an entire AVC or a particular AVC actor group helps prioritize the risks and address them with adequate ARM options. In order to learn more about the risks impacting an AVC or a particular AVC actor group, the AT can create the classic illustration, a risk matrix (Figures F.1 and F.2). For each AVC actor and for the entire value chain, the AT can create risk matrices. The AT can generate these matrices using the data from the spreadsheet template (Annex I), by setting the corresponding references to the data sheets they have created and filled in. These matrices provide visual support to compare different risks, and prioritization can follow the colors of the grid. Risks in the red and orange cells could be designated as priorities. If a few different AVCs are being compared, they can be integrated into one matrix by using different symbols (Figure F.2). If too many risks or AVCs are involved, we recommend making separate matrices for each AVC. In addition, the same matrices can be produced using the maximum loss impact score instead of the average impact score for a prioritization based on maximum losses. The CMR can be also integrated into the graphic by using bubble size to reflect the CMR score (Figure F.3). Finally, a heat map can also furnish a comparison of the values of impact and probability across AVC actor groups (Figure F.4). Figure F.4 shows the probability and impact scores taken from the assessment results in a matrix (from the sheet entitled "Scores" in Annex I). For each AVC actor group, Figure F.4 scores selected examples of weather risks based on impact and on frequency as a substitute for probability.

Figure F.1. Example of a risk matrix.

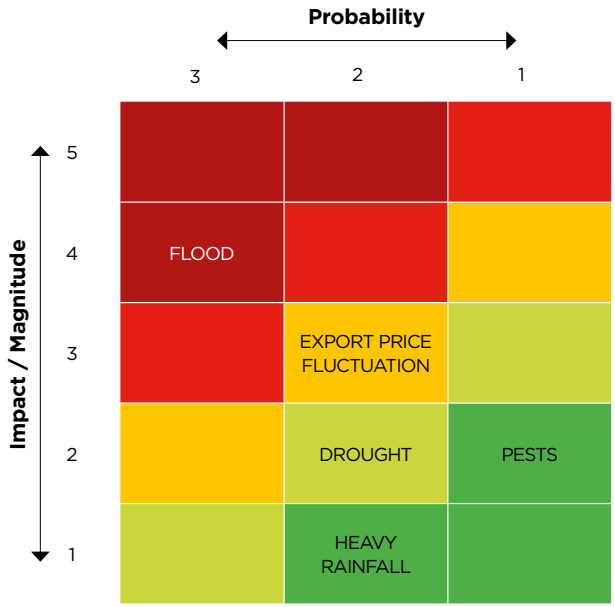


Figure F.2. Example of a risk matrix for 2 agricultural value chains.

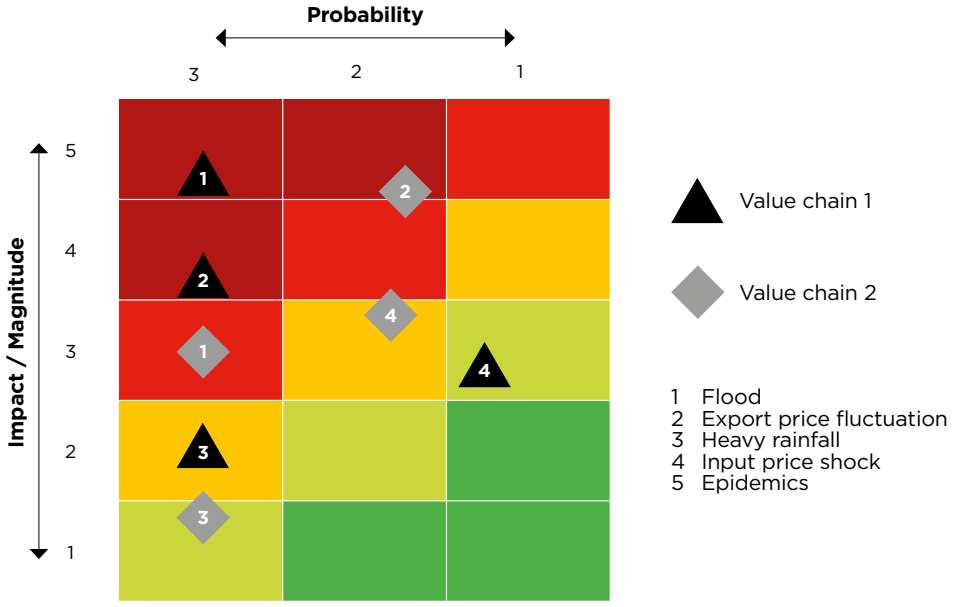


Figure F.3. Example of risk matrix for agricultural value chain actor 1 including the capacity to manage risk.

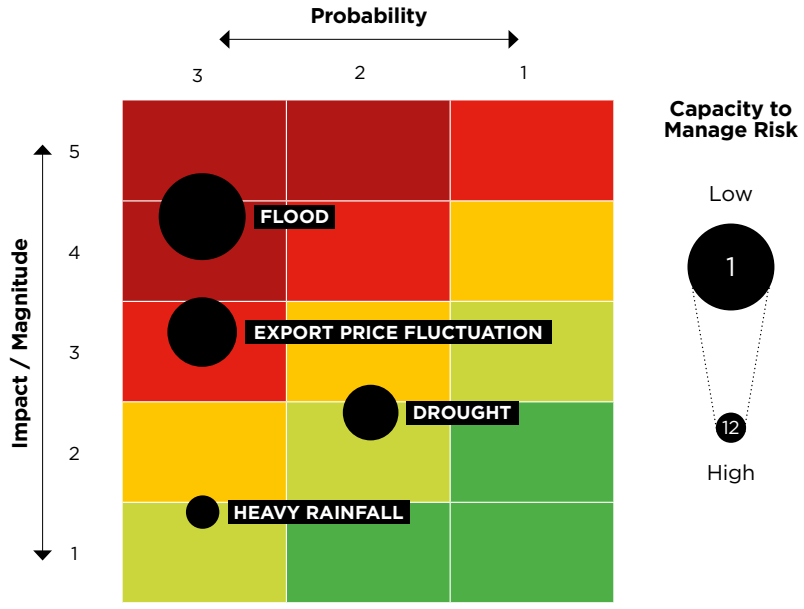
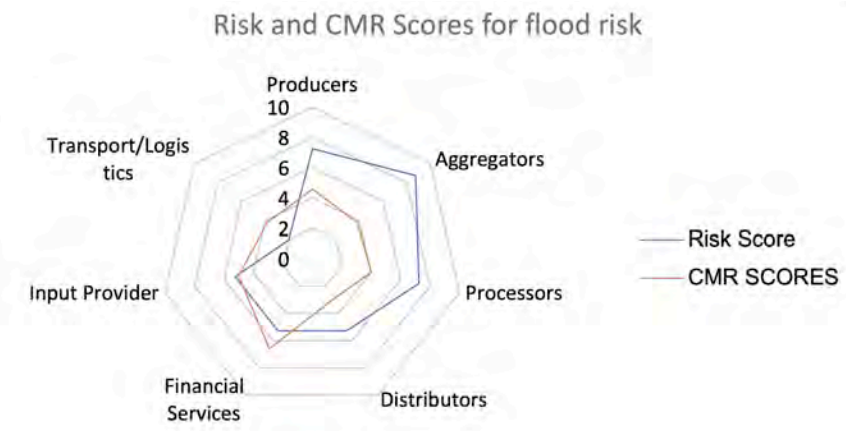


Figure F.4. Sample output after scoring weather-related risks for a given AVC.

Question 2: Which AVC actors are affected by a particular risk, and what is their capacity to handle it?

To better understand how a particular risk affects the AVC, the risk score and the CMR score can be compared by using a spider graph (like the example in Figure F.5). In Figure F.5, the risk exposure is high for producers and processors, and to a certain extent for distributors, financial services, and input providers as well. The CMR, however, is lowest for distributors, aggregators, transport and logistics providers, producers, and processors. Those actors experiencing high risks, with a low capacity to manage them, should be addressed with risk management solutions. The same graphic can be produced for a second AVC if it is within the scope of the study, and the patterns of the spider graphs can be compared. The spider graph can be created directly in the spreadsheet template by following the integrated instructions.

Figure F.5. Example of a spider graph for risk and capacity to manage risk scores.



Question 3: What is the annual average loss associated with each risk for each AVC?

The AT lists the estimated absolute values of annual average loss for each risk and AVC in a table. The table can be formatted as a heat map to better highlight the risks and AVCs associated with a high annual average loss. However, if the available data has gaps, we recommend presenting this table without special formatting (Table F.1).

Table F.1. Example presenting the annual average losses as a percent of production.

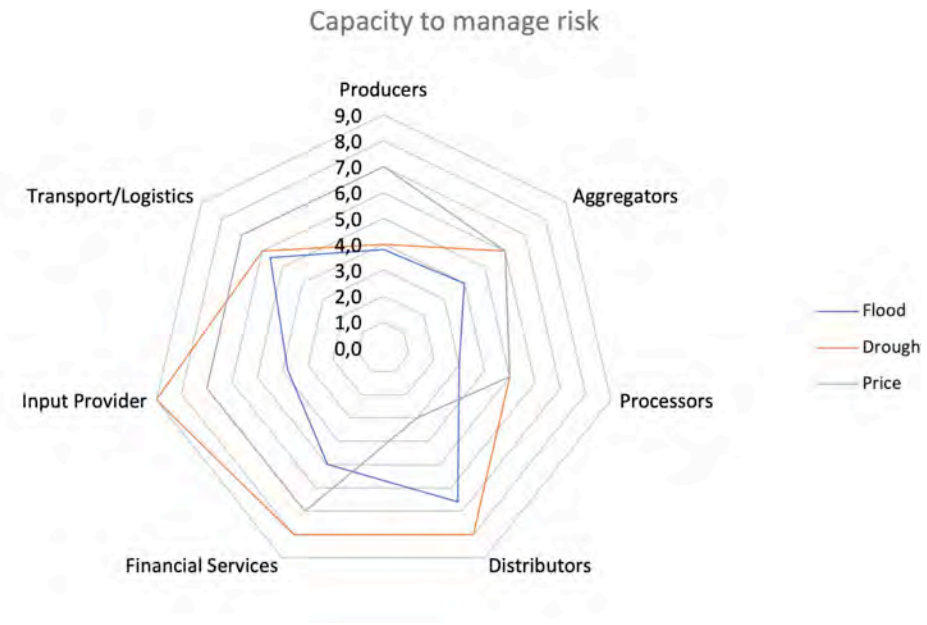
Annual average losses	AVC 1	AVC 2	AVC 3
Risk 1	3%	-	10%
Risk 2	2%	1%	2%
Risk 3	1%	5%	1%
...			

Question 4: Which risk do AVC actors have the lowest capacity to manage?

To define adequate ARM tools and policies, the AT needs to understand AVC actor groups' CMR with regard to different risks. We recommend creating a spider graph in Excel that shows the CMR scores for each risk (Figure F.6). This visualization can shed light on areas that need attention for each AVC actor. From Figure F.6, for example, it is clear that producers have a low capacity to manage flood or drought risk, but a higher capacity to manage price risk. Therefore, the former risks could be areas to address with potential solutions, discussed

in Chapter 5. Input providers, meanwhile, show a relatively low capacity to manage flood risk, but a high capacity to manage drought and price risks. Hence, solutions to support this group would entail building its capacity to manage flood risk.

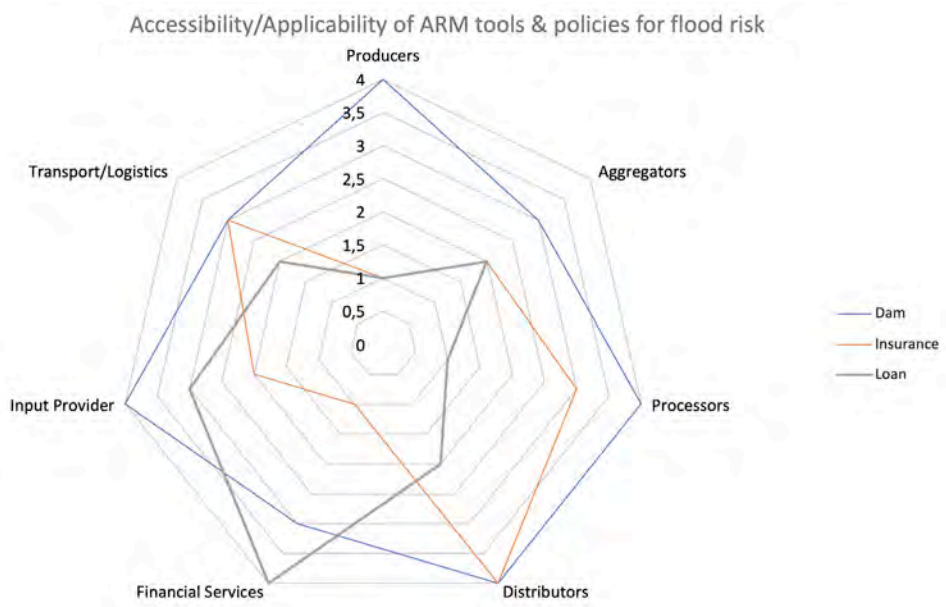
Figure F.6. Example of a spider graph to visualize capacity to manage risk scores.



Question 5: Which AVC actors have access to effective ARM tools to manage a particular risk, and which show a gap?

The CMR analysis values for the accessibility and applicability of each ARM option can be further analyzed and presented in spider graphs or heat maps. The spider graphs must be created for each risk individually, as described in the spreadsheet template. Figure F.7 exemplifies how gaps can be identified, comparing the scores of existing ARM tools and policies that were assessed as indicators of the CMR for each AVC actor group. In Figure F.7, it is clear that all actors benefit from the ARM option "Dam". The ARM tool "Insurance" is only accessible for distributors, and to a lesser extent for processors, transport or logistics providers, and input providers. The ARM tool "Loan" is accessible for financial service providers and input providers, and less so for transport or logistics providers, aggregators, and distributors. Producers have no access to insurance or loans, whereas processors have access to insurance, but not to loans.

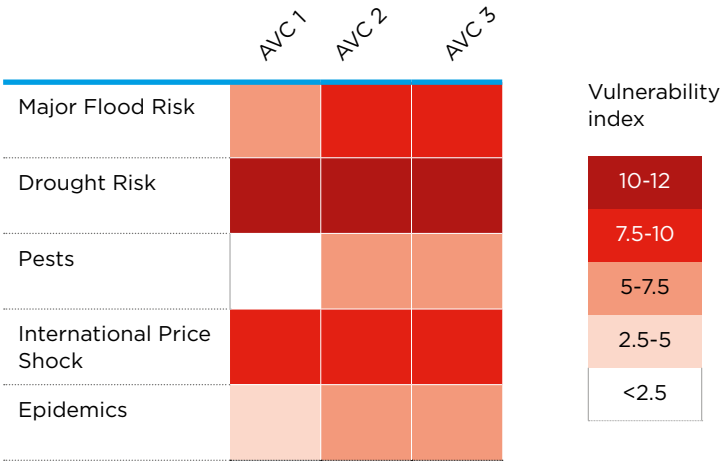
Figure F.7. Example of a spider graph showing gaps in existing agricultural risk management tools and policies for flood risk.



Question 6: Which AVCs show the highest vulnerability indices, and for which risks?

The VI can be visualized with a heat map for each AVC and risk (see Figure F.8). Based on this visualization, the top risks to each AVC can be prioritized. For a quantitative comparison of the agricultural sector's vulnerabilities to these risks, we recommend weighting the VI based on the monetary value of each AVC and drawing a new heat map.

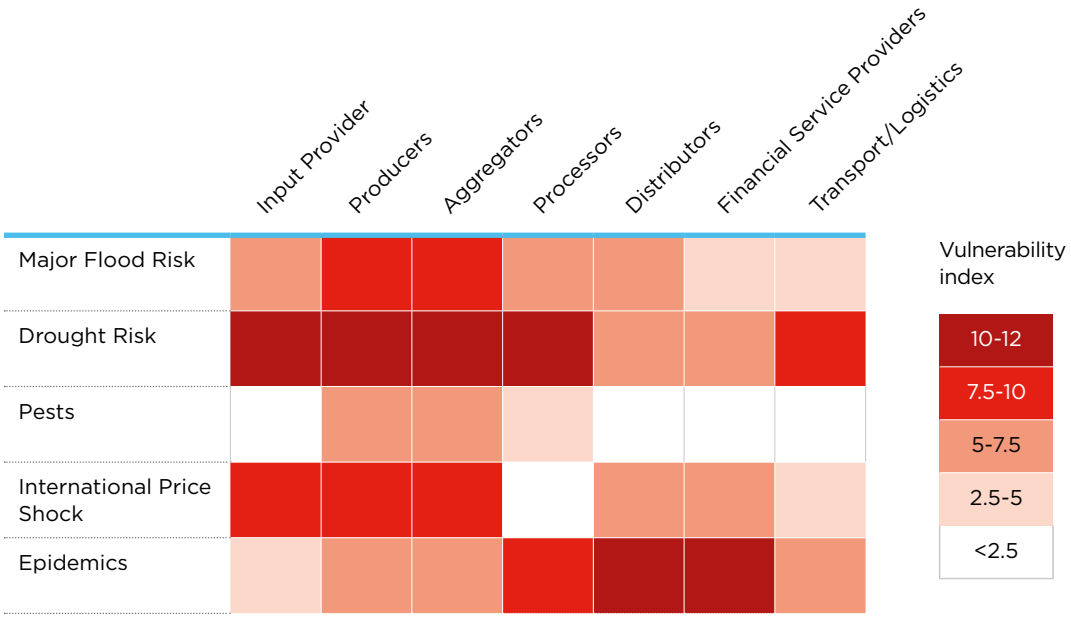
Figure F.8. Comparison of vulnerability indices across agricultural value chains.



Question 7: Which AVC actor groups are the most vulnerable to which risks in the selected AVC(s)?

A heat map allows the VI to be visualized for each AVC actor group and risk (Figure F.9). This visualization can be produced for each selected AVC in the spreadsheet template if all the requisite data is available. By focusing on the cells shaded the darkest red, the AT can identify which groups face the highest vulnerabilities, but also which actors are vulnerable to specific risks. In Figure F.9, for example, the producers and intermediaries are most vulnerable. Drought risk is of the highest concern to producers, whereas epidemics seriously threaten wholesalers and retailers. Vulnerability heat maps for each AVC can facilitate quick identification of actor groups and risks of interest. The same heat map can be produced for the risk score or CMR score.

Figure F.9. Heat map of vulnerability index for each agricultural value chain actor and risk.



This heat map supports the identification of risks and AVC actors that need further attention and therefore more visualizations. The following visualizations should be utilized by the AT specifically for those risks associated with high vulnerability levels.

The AT will choose instruments to best illustrate the risk profile of an AVC and its actors. These visualizations should encompass different perspectives, like comparisons between AVC actors' risk landscapes, across the list of risks, or between AVCs. For the purpose of this AVC-RAS, comparisons across risks and AVCs are possible if the same methodologies were used during each assessment, even though the various assessments are not an exact science and contain biases and subjective judgments. The graphs presented above are examples of how some results of the risk assessment can be illustrated and interpreted.

Annex G: Writing guidelines for the AVC-RAS report

This Annex furnishes writing guidelines meant to encourage the assessment team to formulate their discoveries and results of data collection and workshops in a timely fashion in preparation to compile the final VC-RAS report. It is proposed to continuously draft the sections of the AVC-RAS report as soon as the results of one activity are available. This Annex is structured along the outline of an AVC-RAS report.

Content

G.1. Introduction

The introduction will describe the setting and the context of the study, with an overview of the purpose, country agricultural sector profile, a rough country risk profile, and an introduction of the selected value chains.

Purpose and setting of the study

Information for this section will mainly be collected during the inception phase of the AVC-RAS. This section presents the study's purpose, introduces clients and other potential users of the action plan, and specifies funding and timeline. This section also describes clients' objectives with regard to the agricultural sector and presents the agricultural value chains and geographical area selected as a scope for this study.

Country context

Information for this section is described in section 1.2 of the main document, including the step-by-step process of data collection and the advice, including length requirements, necessary to draft the country context.

Risk Profile

Information for this section is described in section 1.2 of the main document, including the step-by-step process of data collection and the advice, including length requirements, necessary to draft the country context.

Value chains

In section 1.3 of the main document, content and a structure are being proposed for this part of the AVC-RAS report. This section presents the selected agricultural value chains, describing results of the rapid AVC analysis performed. It includes the description of relevant characteristics of the commodities, a map depicting stages and actors, information about the end market, geography, support services and other relevant information about the AVC's context such as social and gender aspects.

G.2. Agricultural Value Chain risk analysis

This section proposes how to write-up a detailed analysis of the value chain risk analysis during the weeks 8 to 9. It contains the following four sections.

Risk assessment

This section describes historical hazard events and a timeline of these events and current risks. The long list of risks is presented with corresponding probability and impact scores for all AVCs and AVC actor groups. A table may be an efficient way to do this, accompanied by a clear summary of major highlights and takeaways and any notable or surprising findings from the risk assessment. The narrative is supported with visuals such as heat maps, risk matrices, or spider graphs. Prioritized risks are explained in more detail, based on information from literature, data analysis, and interviews. This section describes their causes, consequences (including geographical magnitude, average loss, average annual loss, and maximum loss), historical frequency and correlations with other risks, transmissions across the AVC, and other characteristics. Prioritized risks may receive one or more paragraphs of explication and analysis each. Rather than simply listing numbers and data points, these analyses should provide a narrative of the history and causes of a particular risk and explain its consequences within and across the AVC. This should convey an overall sense of the extent and urgency of each risk.

Inventory of existing ARM tools and policies

This section lists existing relevant ARM tools and policies, and provides specific information on them, such as: mechanism, provider, duration, beneficiaries, addressed risks, effectiveness, and constraints. Readers need to understand who is involved in these ARM tools and policies and how they fit into the overall AVC. It should also convey the effectiveness of ARM tools and policies in helping relevant actors manage risks and their influence on AVC actors' vulnerability.

Capacity and vulnerability

This section describes vulnerability for each of the identified risks, along with other relevant vulnerability factors and each actor's CMR, including comparing the conditions of effectiveness and accessibility or applicability of ARM solutions. This section also compares the actor groups' CMR for each risk. Beyond presenting the numbers, the AT is encouraged to interpret and synthesize this data with an eye toward which risks are most pressing, and which actors are most vulnerable. Paying attention to demographic data, such as information about age and gender, can yield telling results in this step.

Prioritization of Risks and Actors

Risk prioritizing means that the process of how risks were prioritized is presented. The results of the risk and vulnerability assessments are introduced, including comparisons for each AVC, using infographics. Risk and vulnerability profiles are presented for each AVC actor. The analysis should explain what prioritizing choices were made by stakeholders, so it is evident how and why each risk has been prioritized, given all the information gathered about probability, impact, and CMR. The vulnerability index of the relevant AVC(s) and AVC actors may be a key variable here, and the analysis should convey how the respective vulnerabilities of different value chains and actor groups underpinned the risk prioritizing.

G.3. Agricultural Risk Management strategies

This part of the AVC-RAS report, featuring an action plan with adequate risk management strategies, also provides a narrative of the selection process and collective decision making for the design of the risk management strategies and action plan. Section 5.2 of the main document describes the process in detail. The report should contain the following sections:

Gap analysis

This section reviews the mapping of prioritized risks with existing ARM tools and policies. This mapping process highlights existing gaps in comprehensive and effective risk management in the value chain. These gaps are described in terms of affected actors and consequence for the value chain. Key information about the prioritized risks such as the associated annual average loss and maximum loss may be worth mentioning as well. It should be clear how the gap analysis provides a basis for the AT to suggest risk management strategies to address these gaps, as described below.

Agricultural risk management strategies

The long list of risk management measures that could be effective to fill the identified gaps suggestions are presented in this section with all the details that are relevant for an investment decision. This section then also explains the criteria used by the client to select a few ARM measures on which further investments should focus.

Action plan

The action plan is the final output of the VC-RAS and provides a concrete investment guide for the client of this study. It offers details on the investments and organization required to implement the selected ARM measures. This deliverable should include concrete figures, an estimation of required investments, roles and responsibilities, activities, a time frame, and other key information. Next steps should be clarified so that it is obvious who needs to do what, when, how, and with what resources.

Monitoring and evaluation

Risk management is a continuous process since risks are constantly changing. Therefore, this AVC-RAS is a snapshot of the AVC's risk landscape. In order to control the risks on a continuous basis, regular monitoring and reassessment of the risk landscape and implemented measures are required which should be mentioned in this section.

G.4. Sources and methodology

In this final portion of the AVC-RAS, all methodologies and data sources are presented. This section discusses the definition and selection of indicators, names and roles of key informants, calculations and models used, assumptions made, etc. Any deviations from this toolkit should be explained in this section. This material may be handily presented in the form of one or more annexes cross-referenced in the main text to support understanding.

Annex H. Interview guidelines

The following guide contains a list of leading semi-structured questions and topics for inquiry to explore with key informats for the purpose of conducting an VC-RAS, with specific questions and themes for the different stages and levels of the value chain.

The themes are divided in different modules as follows:

1. General information of the actor
2. Value chain characterization
3. Risk Identification and analysis
4. Transmission of risks
5. Inventory of existing ARM tools and policies

To capture the role of gender in the assessment, responses from men and women are differentiated and considered throughout.

Agricultural value chain actor groups

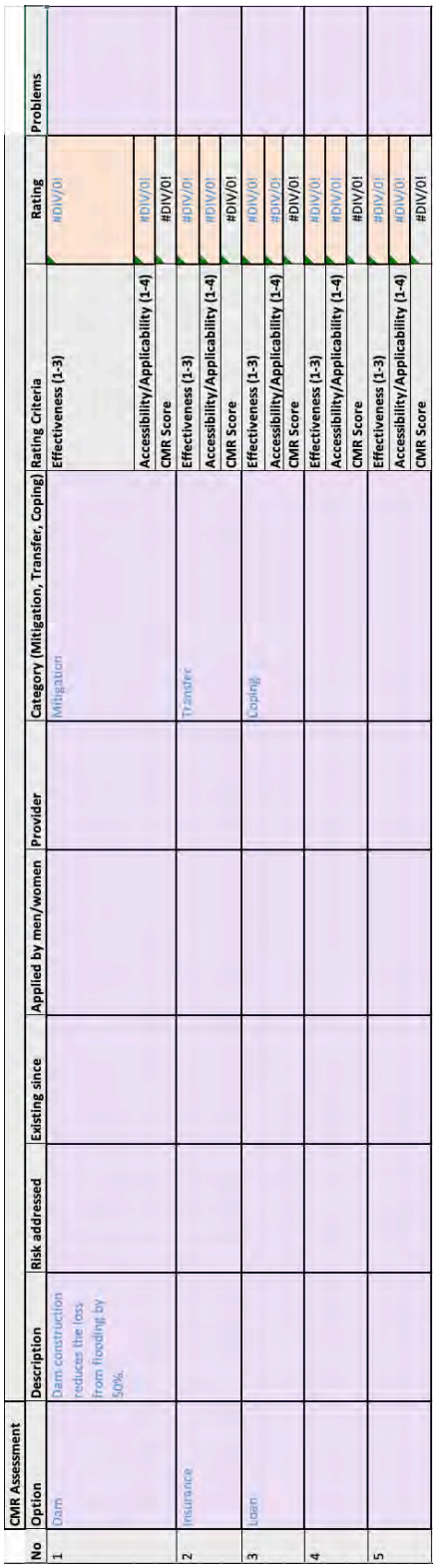
- Producers
- Aggregators
- Processors
- Distributors
- Financial Services
- Input suppliers
- Transport/Logistics

Examples of stakeholders with a good overview of the AVC (generalists)

- Government officials, Sector representatives, Crop boards, State enterprises, Ministry of Agriculture, Development agencies
- Farming organizations
- Extension Service Provider

For question block 3, please use the "Risk Table".

Figure H.1. Screenshot of the CMR Assessment table provided in each sheet of the related Annex H Excel file.



CMR Assessment									
No	Option	Description	Risk addressed	Existing since	Applied by men/women	Provider	Category (Mitigation, Transfer, Coping)	Rating Criteria	Rating	Problems
1	Dam	Dam construction reduces the loss from flooding by 50%.					Mitigation	Effectiveness (1-3)	#DIV/0!	
								Accessibility/Applicability (1-4)	#DIV/0!	
								CMR Score	#DIV/0!	
2	Insurance						Transfer	Effectiveness (1-3)	#DIV/0!	
								Accessibility/Applicability (1-4)	#DIV/0!	
								CMR Score	#DIV/0!	
3	Loan						Coping	Effectiveness (1-3)	#DIV/0!	
								Accessibility/Applicability (1-4)	#DIV/0!	
								CMR Score	#DIV/0!	
4								Effectiveness (1-3)	#DIV/0!	
								Accessibility/Applicability (1-4)	#DIV/0!	
								CMR Score	#DIV/0!	
5								Effectiveness (1-3)	#DIV/0!	
								Accessibility/Applicability (1-4)	#DIV/0!	
								CMR Score	#DIV/0!	

Scan the QR Code with your smartphone's camera to download the Annex H Excel file

https://www.p4arm.org/app/uploads/2021/12/Assessing-value-chain-risks-to-design-agricultural-riskmanagement-strategies_annex-h_Interview-guidelines.xlsx

Questions about the entire AVC

1 General information

1.1 Contact person and title
1.2 Address and location
1.3 Contact details
1.4 Age and sex
1.5 Function, expertise
1.6 Year established (operating in the region)
1.7 Number of employees, % of women

2 Value chain characterization

Who is involved in the value chain analyzed (different stakeholders, segments of population, gender roles, etc.)?
2.1 Types of inputs and outputs supplied, prices and trends
2.2 Volume of inputs and outputs supplied to the value chain
2.3 Important players, competitors
2.4 Who are the main suppliers and customers? Are they men or women? Domestic, international?
2.5 What are the commercial arrangements (formal, informal, special arrangements)? With whom? Are they men or women? What role does gender play in your business relationships?
2.6 How is the AVC financed? Are there public subsidies or credits available? How does it affect the business?
2.7 Role of other actors in the industry (SME, farmer organizations, cooperatives, NGOs, government)
2. Do you have agents/distribution centers? If so, how many? How far are they spread geographically?

3 Risk Identification, Analysis

3.1 What are the main risks to the AVC? e.g. weather, price, environment, labor standards, logistics, operational, trade policies. Which activity is affected, e.g. production, input sourcing, storage/handling, transport or sales of your goods?
3.2 Do you think that men and women face different risks? If so, how? What risks have the greatest impact on women? Are there regional differences in terms of risk exposure of women compared to men?
3.3 Which three risks are you most concerned about? (not constraints, but risks (random, unexpected, sudden))
3.4 Please describe each risk in detail: use the table in the sheet "Risk Table"
3.5 Have you experienced value chain disruptions? If so, what were the reasons?
3.6 Are these impacts different men or women? If so, how?
3.7 When have they occurred in the last 10 years?
3.8 Which key transaction points or interactions do you perceive as the most risky and uncertain? Does gender play a role for these interactions?
3.9 What is your expectation for the future. Do the risks become worse or better? If so, why?

4 Risk Transmission along AVC

4.1 Do the AVC actors have fixed input or output procurement arrangements? If so, which kind and with whom?

4.3 How are goods transported? Are there transport arrangements? What is their reliability?

4.4 What effects does a loss in production have on other actors in the AVC? Who is affected how?

5 For each risk, ask the following questions, and fill in the ratings, as explained in chapter 7.3

5.1 What are your options to address and manage the risk? e.g. irrigation, storage, savings, … → The interviewer lists the 5.2 Since when is this option available?

5.3 Would you say that men and women take the same actions? If not, how and why?

5.4 Who provides these solutions? government, private sector, family and relatives, others

5.5 Are they men or women?

5.6 The interviewer goes through the list and asks for each option:
a. How effective is this option? Provide a rating of 1-3
b. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4

5.7 What are the problems linked to the existing tools?

5.8 Which additional options are you missing? What solutions would you like to have access to? If they are existent, what hinders you in accessing them? The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.9 The interviewer shows the list of risk management solutions that was prepared by the AT, and asks whether he/she thinks these would be interesting to them to apply. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.10 The interviewer calculates the CMR Scores by multiplying the Effectiveness Score with the Accessibility/Applicability Score (see formula). This leads to CMR Scores ranging from 1 to 12. The total CMR Score is calculated as the average of the CMR Scores for the risk under review.

5.11 The interviewer asks the questions 5.1 to 5.10 for other risks identified above, and lists them in the table

5.12 The interviewer shows the CMR Scores of each risk to the interviewee and discusses the ranking.

Questions about Producers

1 General information

1.1 Contact person and title
1.2 Address and location
1.3 Contact details
1.4 Age and sex
1.5 Function, expertise
1.6 Year established (operating in the region)
1.7 Number of employees, % of women

2 Value chain characterization

2.1 Description of the organization and activities
2.2 Prominence and possition in the value chain
2.3 Role in commodity selling - trading
2.4 Producer prices, how are purchasing and selling prices set
2.5 Average annual sales turnover. Share of local sales versus export sales turnover?
2.6 Margins
2.7 Quality specifications required from market and to producers. Standards
2.8 What are the commercial arrangements (formal, informal, special arrangements)? With whom? Are they men or women? What role does gender play in your business relationships?
2.9 Role in service provision (extension, input distribution, financial services)
2.10 Other important farming organizations
2.11 What is the share of small holder farmers in the production system? What is the spatial distribution?
2.12 What are the incentives for smallholders in producing thecommodity? What are the alternatives?
2.13 What are the main bottlenecks for the farmers

3 Risk Identification, Analysis

3.1 What are the main risks you face in with regard to sourcing of inputs, production or sales of your goods? e.g. weather, price, environment, labor standards, logistics, operational, trade policies
3.2 Do you think that men and women in the same position as you face different risks? If so, how?
3.3 Which three risks are you most concerned about? (not constraints, but risks (random, unexpected, sudden)
3.4 Please describe each risk in detail: use the table in the sheet "Risk Table"
3.5 Have you experienced value chain disruptions? If so, what were the reasons?
3.6 Are these impacts different for you because you are a man or a woman? If so, how?
3.7 When have they occurred in the last 10 years?
3.8 Which key transaction points or interactions do you perceive as the most risky and uncertain? Who do you mainly interact with (men or women)? Does gender play a role for your interactions?
3.9 What is your expectation for the future. Do the risks become worse or better? If so, why?

4 Risk Transmission along AVC

4.1 Do you have fixed input procurement arrangements? If so, which kind and with whom?

4.2 Do you have fixed selling arrangements? If so, which kind and with whom?

4.3 How do you transport goods? Do you have transport arrangements? What is their reliability?

4.4 What effects does a loss in production have on other actors in the AVC and the interviewee's contracts?

5 For each risk, ask the following questions, and fill in the ratings, as explained in chapter 7.3

5.1 What are your options to address and manage the risk? e.g. irrigation, storage, savings, … → The interviewer lists the answers the table (see example table below)

5.2 Since when is this option available?

5.3 Would you say that men and women take the same actions? If not, how and why?

5.4 Who provides these solutions? government, private sector, family and relatives, others

5.5 Are they men or women?

5.6 The interviewer goes through the list and asks for each option:
a. How effective is this option? Provide a rating of 1-3
b. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4

5.7 What are the problems linked to the existing tools?

5.8 Which additional options are you missing? What solutions would you like to have access to? If they are existent, what hinders you in accessing them? The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.9 The interviewer shows the list of risk management solutions that was prepared by the AT, and asks whether he/she thinks these would be interesting to them to apply. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.10 The interviewer calculates the CMR Scores by multiplying the Effectiveness Score with the Accessibility/Applicability Score (see formula). This leads to CMR Scores ranging from 1 to 12. The total CMR Score is calculated as the average of the CMR Scores for the risk under review.

5.11 The interviewer asks the questions 5.1 to 5.10 for other risks identified above, and lists them in the table

5.12 The interviewer shows the CMR Scores of each risk to the interviewee and discusses the ranking.

Questions about Aggregators

1 General information

1.1 Contact person and title
1.2 Address and location
1.3 Contact details
1.4 Age and sex
1.5 Function, expertise
1.6 Year established (operating in the region)
1.7 Number of employees, % of women

2 Value chain characterization

2.1 Prominence and possition in the value chain
2.2 Buying trends in the last 5 years. How are purchasingpatterns different now to when they were before?
2.3 Average annual sales turnover. Share of local sales versus export sales turnover?
2.4 How are purchasing and selling prices set
2.5 Margins
2.6 Quality specifications required
2.7 What are the commercial arrangements (formal, informal, special arrangements)? With whom? Are they men or women? What role does gender play in your business relationships?
2.8 Where are the main operations, trading centers and markets
2.9 Other important intermediaries, competitors

3 Risk Identification, Analysis

3.1 What are the main risks you face in with regard to sourcing of products, storage and transport or sales of your goods? e.g. weather, price, environment, labor standards, logistics, operational, trade policies
3.2 Do you think that men and women in the same position as you face different risks? If so, how?
3.3 Which three risks are you most concerned about? (not constraints, but risks (random, unexpected, sudden)
3.4 Please describe each risk in detail: use the table in the sheet "Risk Table"
3.5 Have you experienced value chain disruptions? If so, what were the reasons?
3.6 Are these impacts different for you because you are a man or a woman? If so, how?
3.7 When have they occurred in the last 10 years?
3.8 Which key transaction points or interactions do you perceive as the most risky, uncertain? Who do you mainly interact with, men or women, Does this play a role for your interactions?
3.9 What is your expectation for the future. Do the risks become worse or better? If so, why?

4 Risk Transmission along AVC

4.1 Do you have fixed input procurement arrangements? If so, which kind and with whom?

4.2 Do you have fixed selling arrangements? If so, which kind and with whom?

4.3 How do you transport goods? Do you have transport arrangements? What is their reliability?

4.4 What effects does a loss in production have on other actors in the AVC and the interviewee's contracts?

5 For each risk, ask the following questions, and fill in the ratings, as explained in chapter 7.3

5.1 What are your options to address and manage the risk? e.g. irrigation, storage, savings, … → The interviewer lists the answers the table (see example table below)

5.2 Since when is this option available?

5.3 Would you say that men and women take the same actions? If not, how and why?

5.4 Who provides these solutions? government, private sector, family and relatives, others

5.5 Are they men or women?

5.6 The interviewer goes through the list and asks for each option:
a. How effective is this option? Provide a rating of 1-3
b. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4

5.7 are the problems linked to the existing tools?

5.8 Which additional options are you missing? What solutions would you like to have access to? If they are existent, what hinders you in accessing them? The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.9 interviewer shows the list of risk management solutions that was prepared by the AT, and asks whether he/she thinks these would be interesting to them to apply. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.10 The interviewer calculates the CMR Scores by multiplying the Effectiveness Score with the Accessibility/Applicability Score (see formula). This leads to CMR Scores ranging from 1 to 12. The total CMR Score is calculated as the average of the CMR Scores for the risk under review.

5.11 The interviewer asks the questions 5.1 to 5.10 for other risks identified above, and lists them in the table

5.12 The interviewer shows the CMR Scores of each risk to the interviewee and discusses the ranking.

Questions about Processors

1 General information

1.1 Contact person and title
1.2 Address and location
1.3 Contact details
1.4 Age and sex
1.5 Function, expertise
1.6 Year established (operating in the region)
1.7 Number of employees, % of women

2 Value chain characterization

2.1 Describe the activities undertaken in processing and the derived products
2.2 Prominence and possition in the value chain (volumes purchased and share of sector purchases)
2.3 Who are the main customers, (end markets and segments)
2.4 Market share
2.5 Share of products in local and foreing markets
2.6 Product specifications required by customers (volumes, packing, labeling, size, etc)
2.7 Who are the main suppliers
2.8 Quality specifications required to suppliers
2.9 What are the commercial arrangements (formal, informal, special arrangements)? With whom? Are they men or women? What role does gender play in your business relationships?
2.10 How are purchasing prices set
2.11 Other important processors, competitors

3 Risk Identification, Analysis

3.1 What are the main risks you face in with regard to sourcing, processing or sales of your goods? e.g. weather, price, environment, labor standards, logistics, operational, trade policies
3.2 Do you think that men and women in the same position as you face different risks? If so, how?
3.3 Which three risks are you most concerned about? (not constraints, but risks (random, unexpected, sudden)
3.4 Please describe each risk in detail: use the table in the sheet "Risk Table"
3.5 Have you experienced value chain disruptions? If so, what were the reasons?
3.6 Are these impacts different for you because you are a man or a woman? If so, how?
3.7 When have they occurred in the last 10 years?
3.8 Which key transaction points or interactions do you perceive as the most risky, uncertain? Who do you mainly interact with, men or women, Does this play a role for your interactions?
3.9 What is your expectation for the future. Do the risks become worse or better? If so, why?

4 Risk Transmission along AVC

4.1 Do you have fixed input procurement arrangements? If so, which kind and with whom?

4.2 Do you have fixed selling arrangements? If so, which kind and with whom?

4.3 How do you transport goods? Do you have transport arrangements? What is their reliability?

4.4 What effects does a loss in production have on other actors in the AVC and the interviewee's contracts?

5 For each risk, ask the following questions, and fill in the ratings, as explained in chapter 7.3

5.1 What are your options to address and manage the risk? e.g. irrigation, storage, savings, … → The interviewer lists the answers the table (see example table below)

5.2 Since when is this option available?

5.3 Would you say that men and women take the same actions? If not, how and why?

5.4 Who provides these solutions? government, private sector, family and relatives, others

5.5 Are they men or women?

5.6 The interviewer goes through the list and asks for each option:
a. How effective is this option? Provide a rating of 1-3
b. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4

5.7 What are the problems linked to the existing tools?

5.8 Which additional options are you missing? What solutions would you like to have access to? If they are existent, what hinders you in accessing them? The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.9 The interviewer shows the list of risk management solutions that was prepared by the AT, and asks whether he/she thinks these would be interesting to them to apply. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.10 The interviewer calculates the CMR Scores by multiplying the Effectiveness Score with the Accessibility/Applicability Score (see formula). This leads to CMR Scores ranging from 1 to 12. The total CMR Score is calculated as the average of the CMR Scores for the risk under review.

5.11 The interviewer asks the questions 5.1 to 5.10 for other risks identified above, and lists them in the table

5.12 The interviewer shows the CMR Scores of each risk to the interviewee and discusses the ranking.

Questions about Distributors

1 General information

1.1 Contact person and title
1.2 Address and location
1.3 Contact details
1.4 Age and sex
1.5 Function, expertise
1.6 Year established (operating in the region)
1.7 Number of employees, % of women

2 Value chain characterization

2.1 Describe the activities undertaken in trading
2.2 Prominence and possition in the value chain (volumes traded and market share)
2.3 Who are the main customers (end markets and segments)
2.4 Quality specifications required from customers
2.5 Market share
2.6 Margins
2.7 Who are the main suppliers
2.8 Quality specifications required to suppliers
2.9 What are the commercial arrangements (formal, informal, special arrangements)? With whom? Are they men or women? What role does gender play in your business relationships?
2.10 Other important processors, competitors
2.11 How are purchasing prices set
2.12 Do you have agents/distribution centers? If so, how many? how far are they spread geographically?

3 Risk Identification, Analysis

3.1 What are the main risks you face in with regard to sourcing of inputs, storage and production or sales of your goods? e.g. weather, price, environment, labor standards, logistics, operational, trade policies
3.2 Do you think that men and women in the same position as you face different risks? If so, how?
3.3 Which three risks are you most concerned about? (not constraints, but risks (random, unexpected, sudden)
3.4 Please describe each risk in detail: use the table in the sheet "Risk Table"
3.5 Have you experienced value chain disruptions? If so, what were the reasons?
3.6 Are these impacts different for you because you are a man or a woman? If so, how?
3.7 When have they occurred in the last 10 years? Do you keep a track record of disruptions? If so, could we use it for the RAS?
3.8 Which key transaction points or interactions do you perceive as the most risky, uncertain? Who do you mainly interact with, men or women, Does this play a role for your interactions?
3.9 What is your expectation for the future. Do the risks become worse or better? If so, why?

4 Risk Transmission along AVC

4.1 Do you have fixed input procurement arrangements? If so, which kind and with whom?

4.2 Do you have fixed selling arrangements? If so, which kind and with whom?

4.3 How do you transport goods? Do you have transport arrangements? What is their reliability?

4.4 What effects does a loss in production have on other actors in the AVC and the interviewee's contracts?

5 For each risk, ask the following questions, and fill in the ratings, as explained in chapter 7.3

5.1 What are your options to address and manage the risk? e.g. irrigation, storage, savings, … → The interviewer lists the answers the table (see example table below)

5.2 Since when is this option available?

5.3 Would you say that men and women take the same actions? If not, how and why?

5.4 Who provides these solutions? government, private sector, family and relatives, others

5.5 Are they men or women?

5.6 The interviewer goes through the list and asks for each option:
a. How effective is this option? Provide a rating of 1-3
b. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4

5.7 What are the problems linked to the existing tools?

5.8 Which additional options are you missing? What solutions would you like to have access to? If they are existent, what hinders you in accessing them? The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.9 The interviewer shows the list of risk management solutions that was prepared by the AT, and asks whether he/she thinks these would be interesting to them to apply. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.10 The interviewer calculates the CMR Scores by multiplying the Effectiveness Score with the Accessibility/Applicability Score (see formula). This leads to CMR Scores ranging from 1 to 12. The total CMR Score is calculated as the average of the CMR Scores for the risk under review.

5.11 The interviewer asks the questions 5.1 to 5.10 for other risks identified above, and lists them in the table

5.12 The interviewer shows the CMR Scores of each risk to the interviewee and discusses the ranking.

Questions about Financial Services

1 General information

1.1 Contact person and title
1.2 Address and location
1.3 Contact details
1.4 Age and sex
1.5 Function, expertise
1.6 Year established (operating in the region)
1.7 Number of employees, % of women

2 Value chain characterization

2.1 Describe the financial services provided related to the relevant VC products
2.2 Prominence and position in the value chain (market share)
2.3 Who are the main customers (end markets and segments)? Which AVC links? Are clients mainly women or men and for which products?
2.4 Other important processors, competitors
2.5 What are characteristics of your client portfolio? (sectors, AVCs, crops, actors, farm sizes, location, sex, ...)
2.6 Do you have agents/distribution centers? If so, how many? how far are they spread geographically?
2.7 What are the main requirements for accessing financial services? Are there differences made with regard to the gender?
2.8 What is the role of the government in relation to the financial services

3 Risk Identification, Analysis

3.1 What are the main risks affecting the performance of the AVC? e.g. weather, price, environment, labor standards, logistics, operational, trade policies
3.2 What key risks are affecting the different links of the AVC? Input providers, farmers, intermediaries, processors, traders, wholesalers?
3.3 What impacts do the risks have geographically? exposure?
3.4 Do you think that men and women face different risks? If so, how?
3.5 What key risks are prioritized by the government?
3.6 Please describe each risk in detail: use the table in the sheet "Risk Table"
3.7 Have you observed value chain disruptions? If so, what were the reasons?
3.8 Are these impacts different for men than for women? If so, how?
3.9 When have they occurred in the last 10 years? Do you keep statistics? Could we use them for the RAS?
3.10 Which spillover effects to financial service providers have to be expected with the mentioned risks?
3.11 What is your expectation for the future. Do the risks become worse or better? If so, why?

4 Risk Transmission along AVC

4.1 Which risks are transmitted along the AVC? What dependencies and correlations do exist?

5 For each risk, ask the following questions, and fill in the ratings, as explained in chapter 7.3

5.1 What are your options to address and manage the risk? e.g. irrigation, storage, savings, … → The interviewer lists the answers the table (see example table below)

5.2 Since when is this option available?

5.3 Would you say that men and women take the same actions? If not, how and why?

5.4 Who provides these solutions? government, private sector, family and relatives, others

5.5 Are they men or women?

5.6 The interviewer goes through the list and asks for each option:
a. How effective is this option? Provide a rating of 1-3
b. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4

5.7 What are the problems linked to the existing tools?

5.8 Which additional options are you missing? What solutions would you like to have access to? If they are existent, what hinders you in accessing them? The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.9 The interviewer shows the list of risk management solutions that was prepared by the AT, and asks whether he/she thinks these would be interesting to them to apply. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.10 The interviewer calculates the CMR Scores by multiplying the Effectiveness Score with the Accessibility/Applicability Score (see formula). This leads to CMR Scores ranging from 1 to 12. The total CMR Score is calculated as the average of the CMR Scores for the risk under review.

5.11 The interviewer asks the questions 5.1 to 5.10 for other risks identified above, and lists them in the table

5.12 The interviewer shows the CMR Scores of each risk to the interviewee and discusses the ranking.

Questions about Input suppliers

1 General information

1.1 Contact person and title
1.2 Address and location
1.3 Contact details
1.4 Age and sex
1.5 Function, expertise
1.6 Year established (operating in the region)
1.7 Number of employees, % of women

2 Value chain characterization

2.1 Types of inputs supplied, prices and trends
2.2 Volume of inputs supplied to the value chain
2.3 Important players, competitors
2.4 Who are the main suppliers and customers? Are they men or women? Domestic, international?
2.5 What are the commercial arrangements (formal, informal, special arrangements)? With whom? Are they men or women? What role does gender play in your business relationships?
2.6 How do you finance your business? Are there public subsidies or credits available? How does it affect your business?
2.7 Role of other actors in the industry (SME, farmer organizations, cooperatives, NGOs, government)
2.8 Do you have agents/distribution centers? If so, how many? How far are they spread geographically?

3 Risk Identification, Analysis

3.1 What are the main risks you face with regard to sourcing, storage/handling or sales of your goods? e.g. weather, price, environment, labor standards, logistics, operational, trade policies
3.2 Do you think that men and women in the same position as you face different risks? If so, how?
3.3 Which three risks are you most concerned about? (not constraints, but risks (random, unexpected, sudden))
3.4 Please describe each risk in detail: use the table in the sheet "Risk Table"
3.5 Have you experienced value chain disruptions? If so, what were the reasons?
3.6 Are these impacts different for you because you are a man or a woman? If so, how?
3.7 When have they occurred in the last 10 years?
3.8 Which key transaction points or interactions do you perceive as the most risky and uncertain? Who do you mainly interact with (men or women)? Does gender play a role for your interactions?
3.9 What is your expectation for the future. Do the risks become worse or better? If so, why?

4 Risk Transmission along AVC

4.1 Do you have fixed input procurement arrangements? If so, which kind and with whom?

4.2 Do you have fixed selling arrangements? If so, which kind and with whom?

4.3 How do you transport goods? Do you have transport arrangements? What is their reliability?

4.4 What effects does a loss in production have on other actors in the AVC and the interviewee's contracts?

5 **For each risk, ask the following questions, and fill in the ratings, as explained in chapter 7.3**

5 What are your options to address and manage the risk? e.g. irrigation, storage, savings, … → The interviewer lists the answers the table (see example table below)

5.1 Since when is this option available?

5.2 Would you say that men and women take the same actions? If not, how and why?

5.3 Who provides these solutions? government, private sector, family and relatives, others

5.4 Are they men or women?

5.5 The interviewer goes through the list and asks for each option:
a. How effective is this option? Provide a rating of 1-3
b. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4

5.6 What are the problems linked to the existing tools?

5.7 Which additional options are you missing? What solutions would you like to have access to? If they are existent, what hinders you in accessing them? The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.8 The interviewer shows the list of risk management solutions that was prepared by the AT, and asks whether he/she thinks these would be interesting to them to apply. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.9 The interviewer calculates the CMR Scores by multiplying the Effectiveness Score with the Accessibility/Applicability Score (see formula). This leads to CMR Scores ranging from 1 to 12. The total CMR Score is calculated as the average of the CMR Scores for the risk under review.

5.10 The interviewer asks the questions 5.1 to 5.10 for other risks identified above, and lists them in the table

5.11 The interviewer shows the CMR Scores of each risk to the interviewee and discusses the ranking.

Questions about Transport/Logistic operators

1 General information

1.1 Contact person and title
1.2 Address and location
1.3 Contact details
1.4 Age and sex
1.5 Function, expertise
1.6 Year established (operating in the region)
1.7 Number of employees, % of women
1.8 Capacity of fleet

2 Value chain characterization

2.1 Describe the activities undertaken in transport-logistics related to the VC product
2.2 Prominence and possition in the value chain (volumes and market share)
2.3 Who are the main customers
2.4 What is the annual volume
2.5 Other important processors, competitors
2.6 What are the commercial arrangements with customers? With whom? Are they men or women? What role does gender play in your business relationships?

3 Risk Identification, Analysis

3.1 How do transport risks affect the different actors along the AVC?
3.2 Do you think that men and women in the same position as you face different risks? If so, how?
3.3 Which actors have formalized arrangements with you? How do risk events affect those?
3.4 Which three risks are you as a transport institution most concerned about? (not constraints, but risks (random, unexpected, sudden)
3.5 Please describe each risk in detail: use the table in the sheet "Risk Table"
3.6 Have you experienced value chain disruptions? If so, what were the reasons?
3.7 Are these impacts different for you because you are a man or a woman? If so, how?
3.8 What are the geographical characteristics of the impacts?
3.9 When have they occurred in the last 10 years? Have you kept record?
3.10 Which key transaction points or interactions do you perceive as the most risky, uncertain? Who do you mainly interact with, men or women, Does this play a role for your interactions?
3.11 What is your expectation for the future. Do the risks become worse or better? If so, why?

4 Risk Transmission along AVC

4.1 Which risks are transmitted along the AVC? What dependencies and correlations do exist?

5 For each risk, ask the following questions, and fill in the ratings, as explained in chapter 7.3

5.1 What are your options to address and manage the risk? e.g. irrigation, storage, savings, … → The interviewer lists the answers the table (see example table below)

5.2 Since when is this option available?

5.3 Would you say that men and women take the same actions? If not, how and why?

5.4 Who provides these solutions? government, private sector, family and relatives, others

5.5 Are they men or women?

5.6 The interviewer goes through the list and asks for each option:
a. How effective is this option? Provide a rating of 1-3
b. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4

5.7 What are the problems linked to the existing tools?

5.8 Which additional options are you missing? What solutions would you like to have access to? If they are existent, what hinders you in accessing them? The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.9 The interviewer shows the list of risk management solutions that was prepared by the AT, and asks whether he/she thinks these would be interesting to them to apply. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.12 The interviewer calculates the CMR Scores by multiplying the Effectiveness Score with the Accessibility/Applicability Score (see formula). This leads to CMR Scores ranging from 1 to 12. The total CMR Score is calculated as the average of the CMR Scores for the risk under review.

5.11 The interviewer asks the questions 5.1 to 5.10 for other risks identified above, and lists them in the table

5.12 The interviewer shows the CMR Scores of each risk to the interviewee and discusses the ranking.

Questions about Farming organizations

1 General information

1.1 Contact person and title
1.2 Address and location
1.3 Contact details
1.4 Age and sex
1.5 Function, expertise
1.6 Year established (operating in the region)
1.7 Number of employees, % of women

2 Value chain characterization

2.1 Description of the organization and activities
2.2 Prominence and position in the value chain
2.3 Role in commodity selling - trading
2.4 Producer prices, how are purchasing and selling prices set
2.5 Average annual sales turnover. Share of local sales versus export sales turnover?
2.6 Margins
2.7 Quality specifications required from market and to producers. Standards
2.8 What are the commercial arrangements (formal, informal, special arrangements)? What role does gender play in your business relationships?
2.9 Role in service provision (extension, input distribution, financial services)
2.10 Do you have agents/distribution centers? If so, how many? how far are they spread geographically?
2.11 Other important farming organizations
2.12 What is the share of small holder farmers in the production system? What is the spatial distribution?
2.13 What is the share of women farmers in the production system?
2.14 What are the incentives for smallholders in producing thecommodity? What are the alternatives?
2.15 What are the main bottlenecks for the farmers

3 Risk Identification, Analysis

3.1 What are the main risks farmers face with regard to sourcing of inputs, production or sales of your goods? e.g. weather, price, environment, labor standards, logistics, operational, trade policies
3.2 Do you think that men and women face different risks? If so, how?
3.3 Which three risks are you as a farmer organization most concerned about? (not constraints, but risks (random, unexpected, sudden)
3.4 Please describe each risk in detail: use the table in the sheet "Risk Table"
3.5 Have you experienced or observed value chain disruptions? If so, what were the reasons?
3.6 Are these impacts different for men than for women? If so, how?
3.7 What are the geographical characteristics of the impacts?
3.8 When have they occurred in the last 10 years? Have you kept record?

3.9 Which key transaction points or interactions do you perceive as the most risky, uncertain?
3.10 What risks do you face as farming organization in supporting the AVC?
3.11 What is your expectation for the future. Do the risks become worse or better? If so, why?

4 Risk Transmission along AVC

4.1 Which risks are transmitted along the AVC? What dependencies and correlations do exist?

5 For each risk, ask the following questions, and fill in the ratings, as explained in chapter 7.3

5.1 What are your options to address and manage the risk? e.g. irrigation, storage, savings, … → The interviewer lists the answers the table (see example table below)
5.2 Since when is this option available?
5.3 Would you say that men and women take the same actions? If not, how and why?
5.4 Who provides these solutions? government, private sector, family and relatives, others
5.5 Are they men or women?
5.6 The interviewer goes through the list and asks for each option:
a. How effective is this option? Provide a rating of 1-3
b. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4
5.7 What are the problems linked to the existing tools?
5.8 Which additional options are you missing? What solutions would you like to have access to? If they are existent, what hinders you in accessing them? The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"
5.9 The interviewer shows the list of risk management solutions that was prepared by the AT, and asks whether he/she thinks these would be interesting to them to apply. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"
5.10 The interviewer calculates the CMR Scores by multiplying the Effectiveness Score with the Accessibility/Applicability Score (see formula). This leads to CMR Scores ranging from 1 to 12. The total CMR Score is calculated as the average of the CMR Scores for the risk under review.
5.11 The interviewer asks the questions 5.1 to 5.10 for other risks identified above, and lists them in the table
5.12 The interviewer shows the CMR Scores of each risk to the interviewee and discusses the ranking.

Questions about Government and Sector representatives

1 General information

1.1 Contact person and title
1.2 Address and location
1.3 Contact details
1.4 Age and sex
1.5 Function, expertise
1.6 Year established (operating in the region)
1.7 Number of employees, % of women

2 Value chain characterization

2.1 What is the role of the institution in relation with the VC
2.2 What is the importance of the VC in relation to national objectives (employment, foreign exchange, poverty reduction)
2.3 What are the main markets for the VC
2.4 What are the main producing regions
2.5 Productive seasons
2.6 Who are the main direct actors in the VC
2.7 How is the farm structure (typologies, sizes, distribution of farms per size)
2.8 Who are the main support actors in the VC
2.9 What are the main bottlenecks in the VC

3 Risk Identification, Analysis

3.1 What are the main risks affecting the performance of the AVC? e.g. weather, price, environment, labor standards, logistics, operational, trade policies
3.2 What key risks are affecting the different links of the AVC? Input providers, farmers, intermediaries, processors, traders, wholesalers?
3.3 What impacts do the risks have geographically? exposure?
3.4 Do you think that men and women face different risks? If so, how?
3.5 What key risks are prioritized by the government?
3.6 Please describe each risk in detail: use the table in the sheet "Risk Table"
3.7 Have you observed value chain disruptions? If so, what were the reasons?
3.8 Are these impacts different for men than for women? If so, how?
3.9 When have they occurred in the last 10 years? Do you keep statistics? Could we use them for the RAS?
3.10 Which spillover effects to public and private service providers have to be expected with the mentioned risks?
3.11 What is your expectation for the future. Do the risks become worse or better? If so, why?

4 Risk Transmission along AVC

4.1 Which risks are transmitted along the AVC? What dependencies and correlations do exist?

5 For each risk, ask the following questions, and fill in the ratings, as explained in chapter 7.3

5.1 What are your options to address and manage the risk? e.g. irrigation, storage, savings, … → The interviewer lists the answers the table (see example table below)

5.2 Since when is this option available?

5,3 Would you say that men and women take the same actions? If not, how and why?

5.4 Who provides these solutions? government, private sector, family and relatives, others

5.5 Are they men or women?

5.6 The interviewer goes through the list and asks for each option:
a. How effective is this option? Provide a rating of 1-3
b. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4

5.7 What are the problems linked to the existing tools?

5.8 Which additional options are you missing? What solutions would you like to have access to? If they are existent, what hinders you in accessing them? The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.9 The interviewer shows the list of risk management solutions that was prepared by the AT, and asks whether he/she thinks these would be interesting to them to apply. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.10 The interviewer calculates the CMR Scores by multiplying the Effectiveness Score with the Accessibility/Applicability Score (see formula). This leads to CMR Scores ranging from 1 to 12. The total CMR Score is calculated as the average of the CMR Scores for the risk under review.

5.11 The interviewer asks the questions 5.1 to 5.10 for other risks identified above, and lists them in the table

5.12 The interviewer shows the CMR Scores of each risk to the interviewee and discusses the ranking.

Questions about Extension service providers

1 General information

1.1 Contact person and title
1.2 Address and location
1.3 Contact details
1.4 Age and sex
1.5 Function, expertise
1.6 Year established (operating in the region)
1.7 Number of employees, % of women
1.8 Number of producers served

2 Value chain characterization

2.1 Please describe the organization and activities
2.2 What is the prominence and position of the service in the value chain?
2.3 How is the service financed? What are the roles of public and private sector?
2.4 Do you have agents/distribution centers? If so, how many? how far are they spread geographically?
2.5 Other important extension service providers
2.6 What is the share of small holder farmers in the production system? What is the spatial distribution?
2.7 What are the incentives for smallholders in producing the commodity? What are the alternatives? Are there differences for men and women?
2.8 What is the share of women farmers in the production system?
2.9 What are the main bottlenecks for the farmers? Are there differences for men and women?
2.10 What are the main bottlenecks for the provision of extension services?

3 Risk Identification, Analysis

3.1 What are the main risks farmers face with regard to sourcing of inputs, production or sales of your goods? e.g. weather, price, environment, labor standards, logistics, operational, trade policies
3.2 Do you think that men and women face different risks? If so, how?
3.3 Which three risks are you as a extension service provider most concerned about? (not constraints, but risks (random, unexpected, sudden)
3.4 Please describe each risk in detail: use the table in the sheet "Risk Table"
3.5 Have you observed value chain disruptions? If so, what were the reasons?
3.6 Are these impacts different for men than for women? If so, how?
3.7 What are the geographical characteristics of the impacts?
3.8 When have they occurred in the last 10 years? Have you kept record?
3.9 Which key transaction points or interactions do you perceive as the most risky, uncertain?
3.10 What risks do you face as extension service provider in supporting the AVC?
3.11 What is your expectation for the future. Do the risks become worse or better? If so, why?

4 Risk Transmission along AVC

4.1 Which risks are transmitted along the AVC? What dependencies and correlations do exist?

5 For each risk, ask the following questions, and fill in the ratings, as explained in chapter 7.3

5.1 What are your options to address and manage the risk? e.g. irrigation, storage, savings, … → The interviewer lists the answers the table (see example table below)

5.2 Since when is this option available?

5.3 Would you say that men and women take the same actions? If not, how and why?

5.4 Who provides these solutions? government, private sector, family and relatives, others

5.5 Are they men or women?

5.6 The interviewer goes through the list and asks for each option:
a. How effective is this option? Provide a rating of 1-3
b. What is the actor group's capacity to access or apply the option? Provide a rating of 1-4

5.7 What are the problems linked to the existing tools?

5.8 Which additional options are you missing? What solutions would you like to have access to? If they are existent, what hinders you in accessing them? The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.9 The interviewer shows the list of risk management solutions that was prepared by the AT, and asks whether he/she thinks these would be interesting to them to apply. The interviewer adds them into the table, rates the expected effectiveness, and sets the accessibility rating 1 for "inaccessible"

5.10 The interviewer calculates the CMR Scores by multiplying the Effectiveness Score with the Accessibility/Applicability Score (see formula). This leads to CMR Scores ranging from 1 to 12. The total CMR Score is calculated as the average of the CMR Scores for the risk under review.

5.11 The interviewer asks the questions 5.1 to 5.10 for other risks identified above, and lists them in the table

5.12 The interviewer shows the CMR Scores of each risk to the interviewee and discusses the ranking.

Risk table

Information about Risks

		Probability		Impact					
	List	List	Rate	Estimate	Rate	Estimate	Rate	Name	Name
Description of Risk/ Hazard	**Season at risk (months)**	**Years of historical occurrence**	**Probability**	**Average loss (% reduction of income)**		**Maximum loss (% reduction of income)**		**Root causes**	**Differences in terms of gender**
1			Occasional		Critical		Catastrophic		
2			Probable						
3									
4									
5									

Frequency

Category of probability	Criteria (from Chadhoury et al. 2016)
Highly probable	this event is likely to occur every 3-7 years
Probable	this event is likely to occur every 7-15 years
Occasional	this event is likely to occur every 15-40 years

Impact

Category of impact	Criteria (at least 1 is met)
Catastrophic	• more than 50% reduction in AVC production/income (Chadhoury et al. 2016) • more than 30% reduction in export • 50% or more of the actors engaged in the AVC experience significant income losses • Temporary or permanent shutdown of parts or all value
Critical	• 30-50% reduction in AVC production/income • 20-30% reduction in export • 30% or more actors of the AVC experience significant income losses • Severe disruptions of the value chain
Considerable	• 15-30% reduction in AVC production/income • 10-20% reduction in export • 20-30% of actors of the AVC experience significant income losses • Short term disruptions of the value chain
Moderate	• 5-15% reduction in AVC production/income • less than 10% reduction in export • 10-20% of actors of the AVC experience significant income losses • Deviations in key parameters (costs, demand, logistics)
Negligible	• 0-5% reduction in AVC production • no effect on export • less than 10% of actors of the AVC experience • significant income losses • Minor deviations in key parameters (costs, demand, logistics)s

Annex I. Spreadsheet Risk and Vulnerability Assessment

This Annex corresponds to chapters 2, 3 and 4 of the main document. It should support organizing and structuring the information gathered about the AVC actor groups and their risks and vulnerabilities. This spreadsheet can support the synthesis and improve an overview of the different dimensions, such as risks and AVC actor groups. In order to keep the size of the document manageable, it is recommended to use a different spreadsheet for each selected AVC.

How to use the document

1. In the sheet **Risk Identification**, the identified risks can be listed, and affected actor groups can be marked.
2. After identification of risks, the sheets **Risk 1** and **CMR Risk 1** should be copied for each identified risk.
3. Then, the instructions in each sheet can be followed to enter synthesis results from risk and CMR literature review, data analysis or interviews.
4. Finally, the sheet **Scores** needs to be updated, ensuring that all risk sheets and alls CMR sheets are referred to correctly.

   The sheet **Scores** should provide a table with all scores entered in the previous sheets. Some formulas might have to be adjusted in order to capture the right values.
5. The sheet **Graphics** can be used to visualize the results of the assessments.

Scan the QR Code with your smartphone's camera to download the Annex I Excel file

https://www.p4arm.org/app/uploads/2021/12/Assessing-value-chain-risks-to-design-agricultural-riskmanagement-strategies_annex-i_Synthesis-risk-vuln.xlsx

Annex J: Analyzing weather risks

By Alejandra Esquivel, Harold A. Achicanoy, and Julian Ramirez-Villegas

This Annex J furnishes a detailed description of how to analyze weather risks and corresponds to section 2.2 of the main document.

Content

J.1. Weather risks

In most contexts, and especially where agriculture is rainfed, climate hazards are one of the most important sources of risk. Severe droughts, flash floods, hot and cold spells, late onset of rainfall, excessive rain at harvest, erratic rainfall distribution along the growing period, waterlogged soils, and saline water intrusion are amongst the most common climate hazards affecting AVCs. Measuring weather risk is therefore crucial to the process of quantifying risk in AVCs. It is important to understand that climate variations can generally be grouped into various timescales: weather (1-10 days), sub-seasonal (2-4 weeks), seasonal (2-9 months), interannual, decadal and multi-decadal. These scales are useful to understand climatic variation. Agricultural production risk often involves a complex interplay between all of these scales. For example, 10 consecutive dry days can be said to be a weather event, but they can occur in the context of a season with more such events, change in intensity between years and can be increasing in intensity over the long term. Thus, when we refer to 'seasonal' drought, this is effectively a drought event that is relevant to a season (e.g., a growing season of three, four or more months), but this event can be related to shorter-term variations, as well as to longer-term ones. For the purpose of this toolkit, we consider climate hazard indices that are relevant to agricultural production and assess their interannual frequencies and intensities. This allows to understand climate hazards and risk

for AVCs in an integrated way, as opposed to trying to disentangle the timescales of climatic variation. It is important to note that decadal or multi-decadal trends as risk factors are not in scope of this analysis, the scope is limited to interannual variability. The following steps show how a simple weather risk model can be applied to quantify and estimate these risks.

J.2. Process of a weather risk analysis

The **first step** of the analysis is to select a set of indicators for the weather risks identified in previous steps. The data analysis is helping to understand frequency and intensity of hazards. The intensity is representing for example the amount of rainfall, or the number of subsequent days without rainfall. It does not allow for any statements about a hazard's impact. In table J-1, a list of the most common weather risks, indicators and indices can be found. These weather risks and indices are designed to be representative of the broadest possible range of issues affecting AVCs; however, if needed it is possible to add indicators, provided that these can be computed using existing weather and soil data and that the AT has the capacity to do so. This toolkit will provide support for the assessment of the most common weather indices.

Table J.1. Hazards and indicators to include in the climate risk analysis.

Index	Description	Hazard	Categories
TAI	Thornthwaite's aridity index.	Drought. TAI compares precipitation with potential evapotranspiration and provides a measure of meteorological drought.	No significant stress: <40 Moderate stress: 40–60 Severe: 60–80 Extreme: >80 Unit: percentage (%)
NDD	Total number of dry days (precipitation < 1 mm day-1) during the growing season.	Drought. Many days without rain during the growing season reduce productivity or cause crop failure.	No significant stress: < 15 Moderate: 15 to 20 Severe: 20 to 25 Extreme: > 25 Unit: average number of days per month
NDWS	Moisture stress. Number of days with a ratio of actual to potential evapotranspiration below 0.5.	Drought. Crops experience wilting due to constantly low soil moisture levels during the growing season.	No significant stress: < 15 Moderate: 15 to 20 Severe: 20 to 25 Extreme: > 25 Unit: average number of days per month
LGP	Length of growing period.	The growing season is too short and does not allow for crop production	No significant stress: >120 Moderate: 60 to 120 Severe: 40 to 60 Extreme: < 40 Unit: total number of days

(...)

(...)

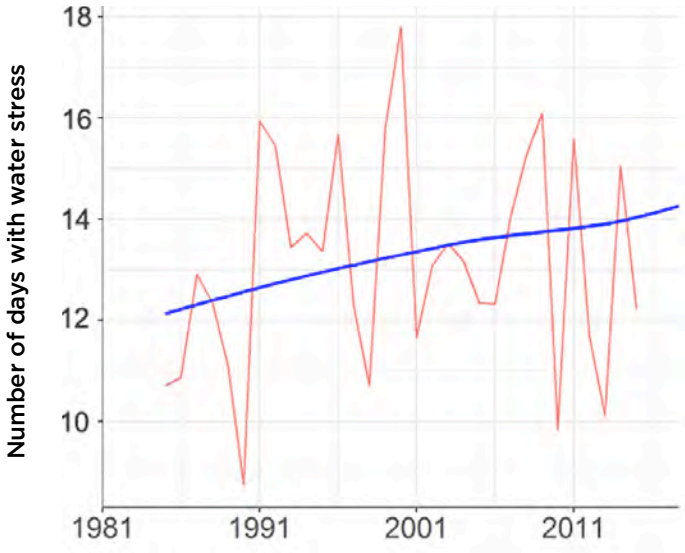
Index	Description	Hazard	Categories
P5D	Maximum 5-day running average precipitation.	Flooding. Too much rainfall in a week leads to flooding, which causes crops to wilt	No significant stress: <40 Moderate: 40 to 80 Severe: 80 to 120 Extreme: >120 Unit: millimeters (mm)
P95	The 95th percentile of daily precipitation.	Flash flooding. Too much rainfall in a single day can result in flash flooding and potentially landslides	No significant stress: <15 Moderate: 15 to 30 Severe: 30 to 60 Extreme: >60 Unit: millimeters (mm)
NWLD	Number of days during the growing season with waterlogging in the soil.	Waterlogging. Many days with the soil at saturation causes roots to rot and leads to crop failure.	No significant stress: <2 Moderate: 2 to 5 Severe: 5 to 8 Extreme: > 8 Unit: average number of days per month
NT-X	Number of days with temperatures above a threshold of X ºC, with X specified for a given crop, geography, or system.	Heat stress for crops. Many hot days during the growing period lead to low crop productivity and affect human labor.	No significant stress: 0 Moderate stress: 1 to 5 Severe stress: 5 to 10 Extreme stress: > 10 Unit: average number of days per month
THI	Temperature Humidity Index. The THI combines temperature and relative humidity data to assess the occurrence of heat stress for livestock.	Heat stress for livestock. Heat stress can reduce meat and milk productivity, or even lead to death.	No or mild stress: ≤ 78 Moderate stress: 79 to 89 Severe stress: ≥90 Unit: dimensionless
HI	The thermal index is used to measure heat discomfort in humans.	Heat stress for humans. Heat stress can reduce labor productivity.	No or mild stress: < 32 Moderate stress: 32 to 41 Severe stress: 41 to 54 Extreme stress: > 54 Unit: Celsius degree (ºC)

For each selected weather risk indicator, the **second step** is then to review and, where needed, adjust the set of predefined intensity categories. Each of the hazards listed in table J-1 has a set of predefined categories that help qualify the intensity of the hazard. The categories of intensity are (i) no significant stress, (ii) moderate stress, (iii) severe stress, and (iv) extreme stress. The suggested categories are generic, intended to work on a continental or global scale, but they can change depending on the AVC or context, such as a country or region of interest. To redefine these categories, the AT can follow one or more of the following three approaches: (i) use maps of each indicator to reclassify them relative to the entire area of interest, for example by using quantiles or simple clustering; (ii) review the literature to identify thresholds at which these different indicators become dangerous to the crop production; and (iii) conduct expert consultations to identify these thresholds.

We underscore the importance of adequately defining the intensity categories of interest and their corresponding thresholds, considering the specific context of the AVC. If such revision is not possible, the assessment can be based on the categories proposed in Table J.1.

The **third step** is to compute the historical frequency of the occurrence of the weather events (indices) with severe and extreme categories, following the methods specified in section J.3 below. We focus on these categories since they are the most likely to result in significant impacts on the crop production. For this numerical analysis, the period and season of interest need to be defined. For instance, for a given country, the AT may select a historical period between 1981–2010 for the June-July-August season. These seasons may vary depending on the AVC chosen, since crops are grown, harvested, processed, stored, transported, and sold at different times of the year. It is also possible to perform the analysis for the entire year (January – December). It is important that the historical period chosen is consistent across hazards and sufficiently long to capture the characteristics of historical weather variables. The calculation of these indicators produces a set of geographical maps that depict spatial variation in each of the indicators, as well as time series plots – for each location or averaged over a spatial domain – which show temporal variability (Figure J.1).

Figure J.1. Sample time series plot showing the number of days with water stress.



For the geography and AVC of interest, the average frequencies (probabilities of occurrence) for both the severe and extreme categories should be calculated, added together, and entered into a spreadsheet template (Annex I). Table J-2 shows the result using sample data. The third and fourth column in the table show the probabilities of events with severe and extreme intensity to occur. The sum of these probabilities will lead to the total probability which can also be expressed as the return period. Based on this information, the hazards can be assigned a Probability score. In this example, the sample categories of section 2.3 of the main document were used.

Table J.2. Example of frequency category estimation for the full set of climate hazards.

Hazard	Index	Probability for each intensity		Total probability	Return period in x years	Probability score	Description
		Severe	Extreme				
Drought	TAI	0.15	0.10	0.25	4.00	3	High probable
	NDD	0.15	0.15	0.30	3.33	3	High probable
	NDWS	0.15	0.12	0.27	3.70	3	High probable
Growing season reliability	LGP	0.03	0.01	0.04	25.00	1	Occasional
Flooding	P5D	0.03	0.02	0.05	20.00	1	Occasional
	P95	0.03	0.01	0.04	25.00	1	Occasional
Waterlogging	NWLD	0.05	0.04	0.09	11.11	2	Probable
Heat stress crops	NT-X	0.25	0.15	0.40	2.50	3	High probable
Heat stress livestock	THI	0.20	0.15	0.35	2.86	3	High probable
Heat stress humans	HI	0.20	0.12	0.32	3.13	3	High probable

Once the frequency category is identified, the **fourth step** is to determine the impact of each hazard for each part of the AVC. Quantifying the impact of a given hazard (characterized by frequency and intensity) on production requires either some type of impact modeling (e.g., crop models), or expert consultation. Considering the time frame and the objective of the AVC-RAS to identify impacts on all parts of the AVC, the AT should achieve an impact estimation through stakeholder consultation. These consultations can be performed through online or phone surveys, or via interviews with experts or AVC actors during fieldwork. For each hazard, the average loss, average annual loss, and maximum loss should be estimated for each AVC actor and entered into the spreadsheet template (Annex I). As a supplement to these methods, the sources and datasets in Annex B.9 can shed light on weather risks in local contexts.

J.3. Application of a weather model

This section describes a model to assess weather risks and its application to an AVC-RAS. At the national or regional level, this model provides an overview of historical weather risks over the 30-year period from 1985 to 2015. It estimates the most-impacted areas where weather risk events are likely to take place. The information generated can be used as an input to compare with the places where agriculture or livestock production is developing to indicate possible risk effects in the early steps of the value chain cycle. The developed model provides a country-level or regional overview of potential weather risks over historical and future periods, estimating the likely impact and the regions where it will occur. Below is a detailed description of inputs, methodology, and results.
The proposed method consists of a time series analysis of climate data using the R statistical software, version 4.0.2. Temperature, precipitation, solar radiation, and soil variables are used to calculate agroclimatic indices that quantify the impact of historical changes on the principal value chains under study. The analysis is carried out at a 5 km^2 resolution.

The model follows these steps.

i. Historical and future data extraction: using free-climate databases, a spatiotemporal database is constructed for the specific country or region of interest.

ii. Data processing is applied to guarantee good data quality.

iii. Time series indexes are constructed to quantify the weather risks present in the region. This method estimates indexes in three categories: heat, drought, and moisture or flood risks.

iv. Finally, trends and changes across spatial locations are quantified. All the risks are combined by the assessment of the frequency and strength of the indexes.

v. The operationalization of the weather risk model is done through an r-notebook as is shown in the figures below; resources can be found here: https://github.com/haachicanoy/climate-risk-profiles.

Variables and climate datasets

Historical climate information is the basis to estimate the likely impact and regions where weather risk events such as drought, flooding, and heat stress have taken place or will occur. It is possible to utilize this method at country or regional level based on the interest of the analysis. The input data consists of the following climate variables.

- Precipitation information (mm/day) is obtained from the Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) daily dataset spanning a 50°S-50°N latitudinal range and the complete longitudinal range. This dataset covers the period from 1981 to 2020 and has a 0.05° resolution equivalent to 5 km^2 at the Equator. For more information, refer to the website or to Funk, et al. (2015).
- **Temperature** data (°C/day), in the form of daily maximum and minimum temperatures, can be obtained from the Climate Hazards Group InfraRed Temperature with Station (CHIRTS) daily dataset. This CHIRTS data covers a latitudinal range of 60°S-70°N and the complete longitudinal range. It has the same spatial resolution of 5 km^2 at the Equator and covers the years 1983-2016.
- **Solar radiation** ($MJ\ m^{-2}d^{-1}$) is provided by the National Aeronautics and Space Administration (NASA). The dataset contains daily incident solar radiation, Tmax, Tmin, dewpoint temperature (Tdew), precipitation, wind speed, and relative humidity (RH) data for each 1° × 1° grid, equivalent to approximately 111 km^2 at the Equator. This data is available on the NASA Prediction of Worldwide Energy Resources website.

The following soil variables are used in addition:

- **Elevation** (m) is obtained from a Digital Elevation Model at a spatial resolution of 90 m^2. To download this data, the AT can use R statistical software, the package "raster", and the function "getData".
- **Soil variables** include soil organic carbon content, cation exchange capacity, soil pH in H_2O, sand content, silt content, clay content, and bulk density. The data source is the ISRIC SoilGrids database. This data is used to calculate the soil water capacity, which enables the measurement of water stress. Its spatial resolution is 250 m^2.

Finally, to determine national or regional administrative units, the latest version of the Database of Global Administrative Areas can be accessed through R using the package "raster" and the function "getData". The administrative units can be defined at level of the country, department, or municipality, and for some specific countries at district or commune level, depending on the scope of the analysis.

Weather risks quantification

To determine the weather risk conditions using the climate and soil variables, the following agroclimatic indices are calculated in this model. Each of those is mapped to a specific risk as presented in Table J.3 and Figure J.2.

Table J.3. Agroclimatic indices used in the model.

Risk	Code	Agroclimatic index	Variables used	Units	Sign interpretation
Drought	CDD	Maximum number of consecutive dry days (a dry day is defined as a day in which total precipitation is below 1 mm)	Precipitation	Days	High: worst
Flooding	P5D	Maximum 5-day running average precipitation	Precipitation	mm/day	High: worst
Flooding	P95	95th percentile of daily precipitation	Precipitation	mm/day	High: worst
Heat	NT35	Total number of days with maximum temperature greater or equal to 35°C	Maximum temperature	Days	High: worst
Drought	NDWS	Average number of days with water stress	Maximum and minimum temperature, precipitation, soil water capacity	Days	High: worst
Growing season related	SLGP	Start of the growing season	Maximum and minimum temperature, precipitation, soil water capacity	Day of the year	Expert knowledge
Growing season related	LGP	Length of the growing season	Maximum and minimum temperature, precipitation, soil water capacity	Days	Expert knowledge
	HDZ	Hazards combination layer	CDD, P5D, P95, NT35, NDWS, SLGP, LGP mean, SD, and trend		-

Figure J.2. A list of weather risks for analysis in Sud-Ouest County, Burkina Faso as an example.

Index	Name	Units
CDD	Number of consecutive dry days	Days
P5D	Maximum 5-day running avarage precipitation	mm/day
P95	95th percentile of daily precipitation	mm/day
NT35	Total number of days with maximum temperature greater or equal to 35°C days	Days
NDWS	Moisture stress	Days
SLGP	Start of growing season	Day of the year
LGP	Length of growing season	Days
HDZ	Hazards	-

Three risk categories are covered by the proposed indices: droughts, flooding, and heat stress. Additionally, two indicators related to the start and duration of growing seasons across the years – in other words, related to rainfall patterns – are calculated. Those indicators can also reveal alterations in planting and harvest dates over the years.
Lastly, a hazard combination map is created using the first two principal components derived from the Principal Component Analysis (PCA) method. To estimate this two-composite index, the following steps are necessary:

- For each pixel or site in the study area, calculate the following summaries: the long-term average, standard deviation, and the trend, which is the slope of the time series for each index.
- Using these 21 variables – 7 indices x 3 summaries – execute the PCA method and extract the first two principal components. These two principal components summarize the intensity and magnitude of the four risk categories over time and give an indication of the most affected sites, which will have high values in the two principal components.
- Using the two principal components, categorize them using terciles into three categories to determine the intensity and magnitude of the weather risks.

Up to the present, the determination of the hazard combination map uses the whole list of indices. However, for future developments it would be possible to select the weather risks of interest and calculate the hazard combination map using this subset.

Crop calendar definition

For each study area, whether a country or a region, is important to determine the crop calendar based on the crop or crops of interest, which specifies the months when each crop is planted and harvested. The crop calendar determines the months for which agroclimatic indices will be calculated – either a subset of months or the whole year.

Computational requirements

The following hard- and software is required to run the model.

Hardware

- 16 GB RAM memory.
- At least a 500-GB hard disk.
- Multicore processor: Intel core i7 8th Generation (recommended).

Software

- Operating System: Windows 10, macOS, Linux.
- R statistical software (version > 4.0)
- Latest version of R Studio

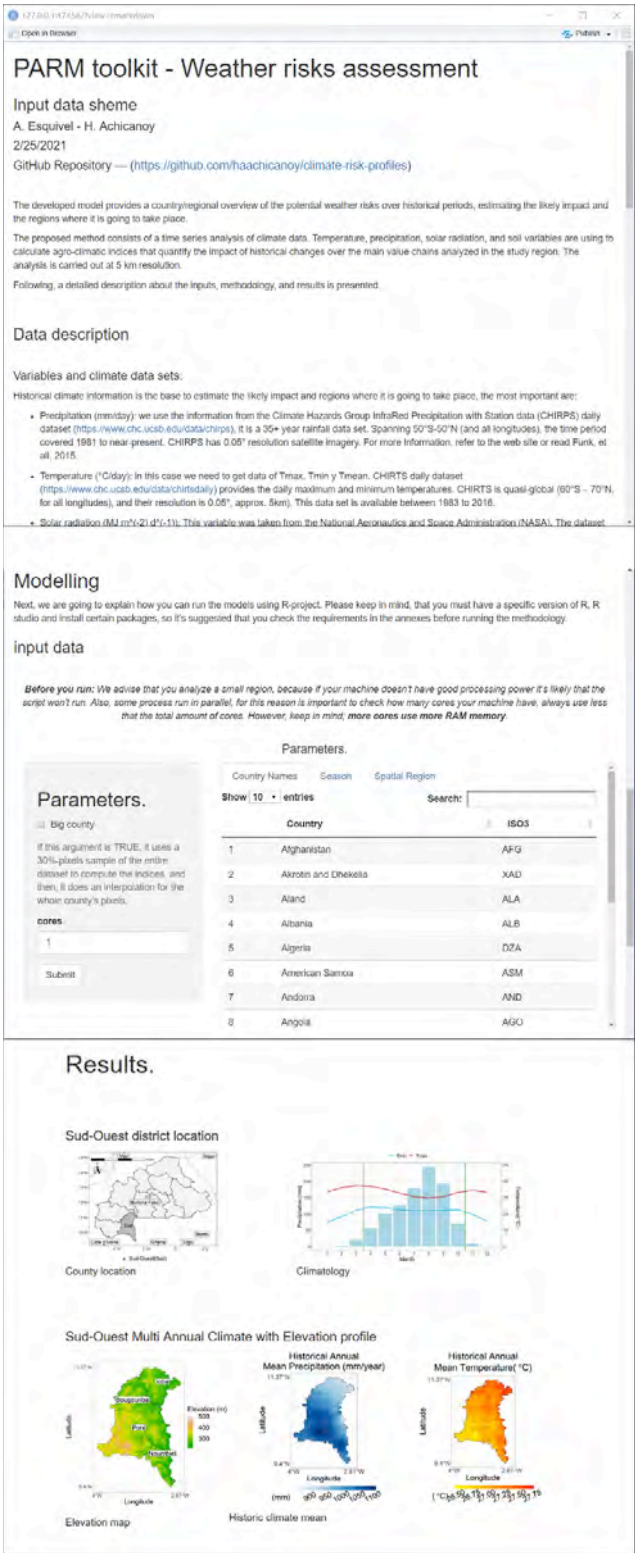
R packages: tidyverse, dplyr, DT, sp, sf, leaflet, raster, ncdf4, rgdal, shiny, glue, pacman, compiler, stringr, stringi, GSIF, vroom, future, furrr, lubridate, fst, ggspatial, cowsay, tibble, FactoMineR, factoextra, ggplot2, tidyr, rmarkdown.

Instruction how to run the interactive notebook

The weather risks assessment method is written in R code through a set of scripts. The scripts perform a list of steps to process the climate and soil variables, filter the temporal information using the crop calendars, calculate the agroclimatic indices, and produce the graphs.

To execute the code without R coding experience, an interactive notebook (Figure J.3) is constructed to leverage the web capabilities and R versatility to run on web servers.

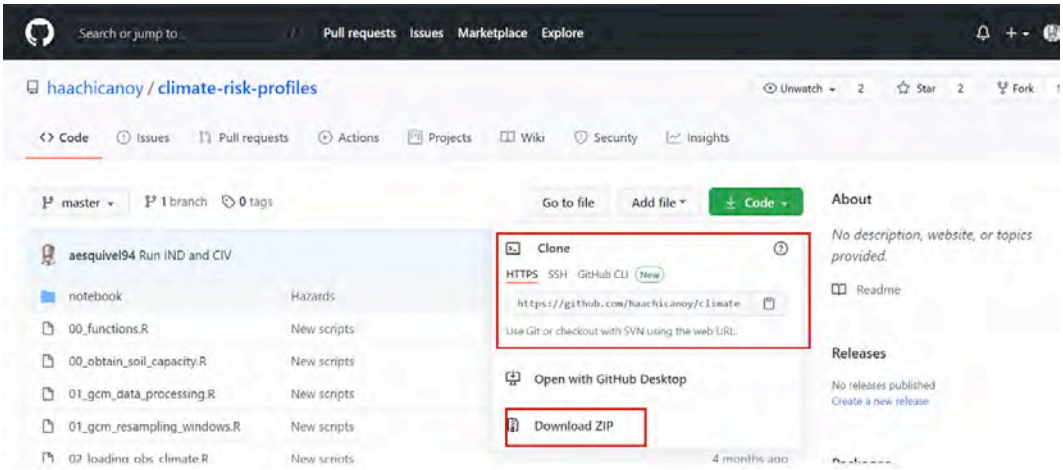
Figure J.3. Screenshot of the interactive notebook (under development).



Step 1 – Code download

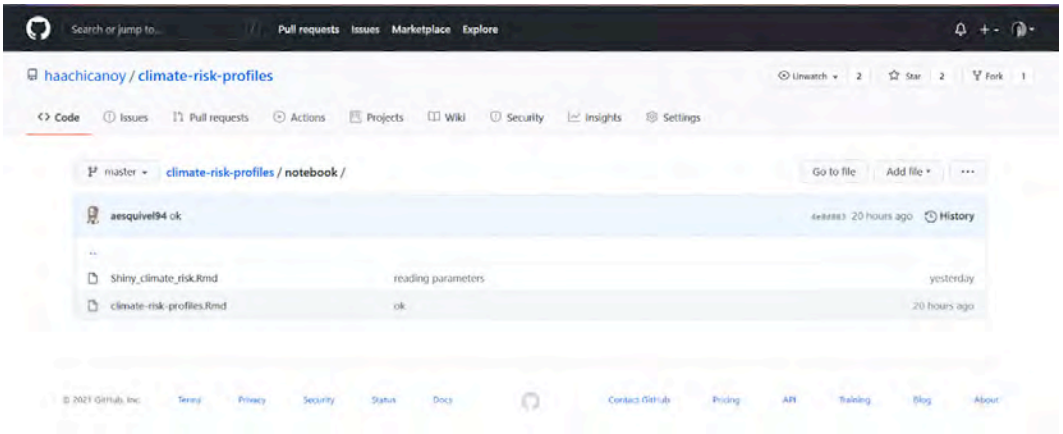
From the GitHub repository, one can download or clone this repository onto your computer (see Figure J.4 for how to download the code).

Figure J.4. Screenshot of GitHub repository.



In the "notebook" folder there is a script called "Shiny_climate_risk.Rmd" that must be executed in RStudio (see Figure J.5). This script captures the input parameters as explained in the following section.

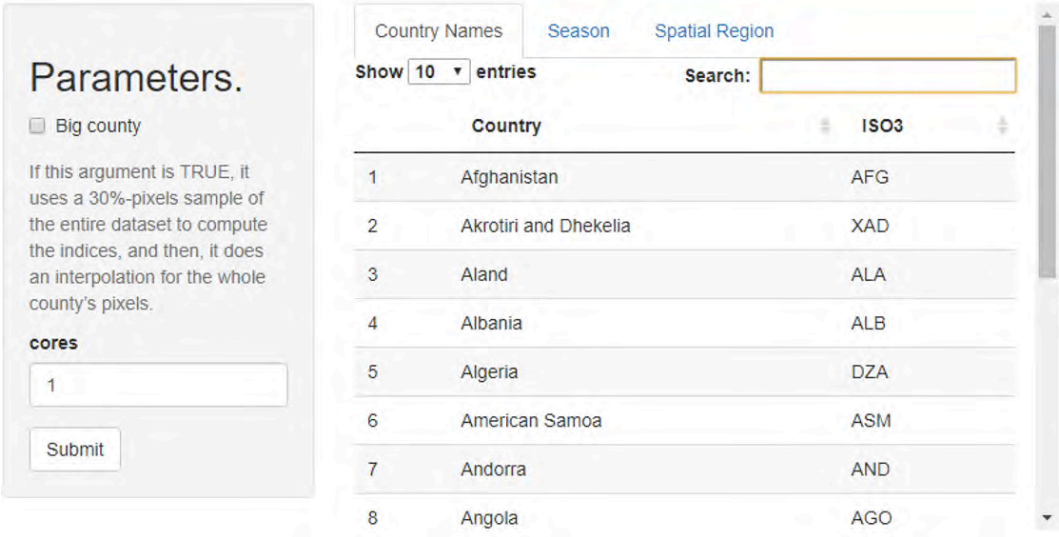
Figure J.5. Screenshot of Shiny interactive app to obtain input parameters.



Step 2 – Input parameters

To enter the parameters to execute the code, an interactive interface enables users to determine the study region, the number of pixels or sites to use in calculations, and the definition of the crop calendar.

Figure J.6. Screenshot of Shiny app to capture input parameters.

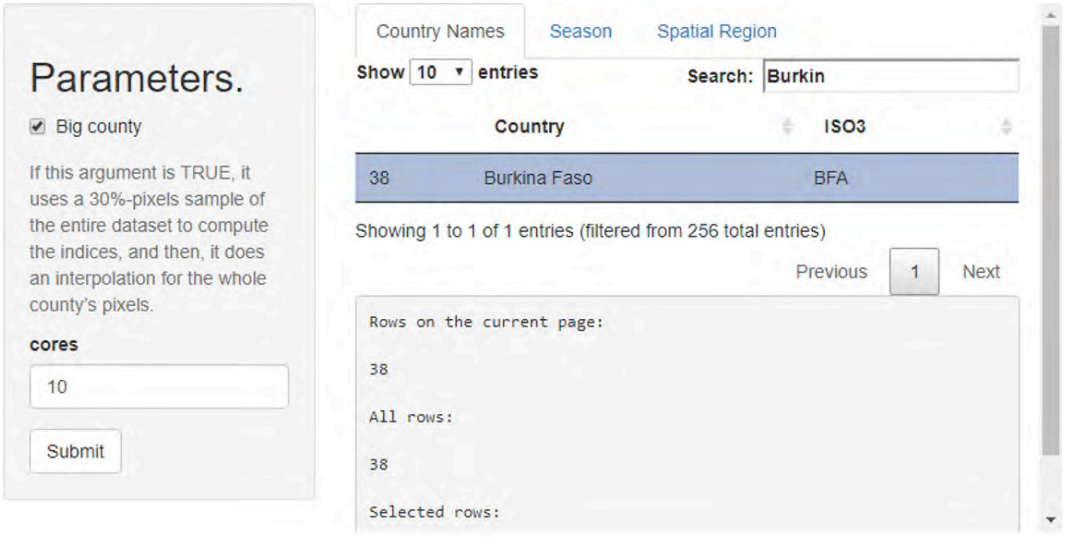


In the left panel called "Parameters" appear two parameters (Figure J.6):

- Big county: The script uses a random sample of 30%-pixels of the entire dataset to compute the indices, and then it performs an interpolation for the whole county's pixels. If this parameter is not activated, all the pixels of the country are used for the calculations. We recommend activating this parameter when considering a large county because it may take a long time to process the information, and enabling this function greatly reduces the processing time. However, if you are analyzing a very small county, it is advisable to keep this parameter disabled.
- Number of cores: This parameter corresponds to the execution of the code in parallel using the defined number of processor cores. The more cores the user chooses the shorter is the execution time; however, raising the number of cores could increase the RAM use.

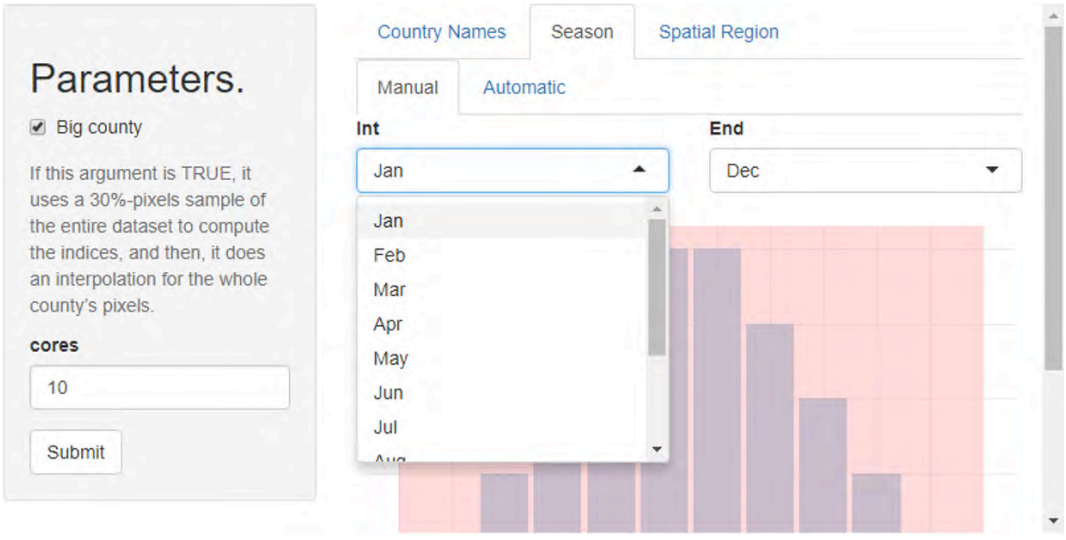
In the right panel, in the "Country Names" tab, it is possible to introduce text to find the corresponding country name in the "Search" bar (Figure J.7). The following screenshot shows an example that involves running a region of Burkina Faso, where the "Big county" option was selected, and 10 cores were specified.

Figure J.7. Screenshot showing how to select a country.



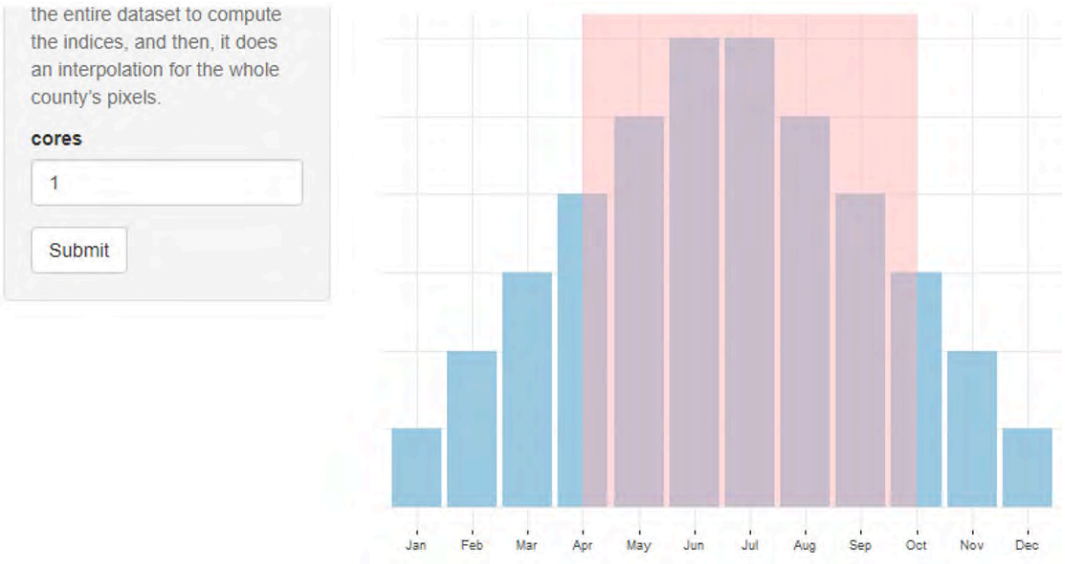
In the next tab entitled "Season", there are options to define the crop calendar either manually or automatically (Figure J.8).

Figure J.8. Screenshot demonstrating how to define the crop calendar.



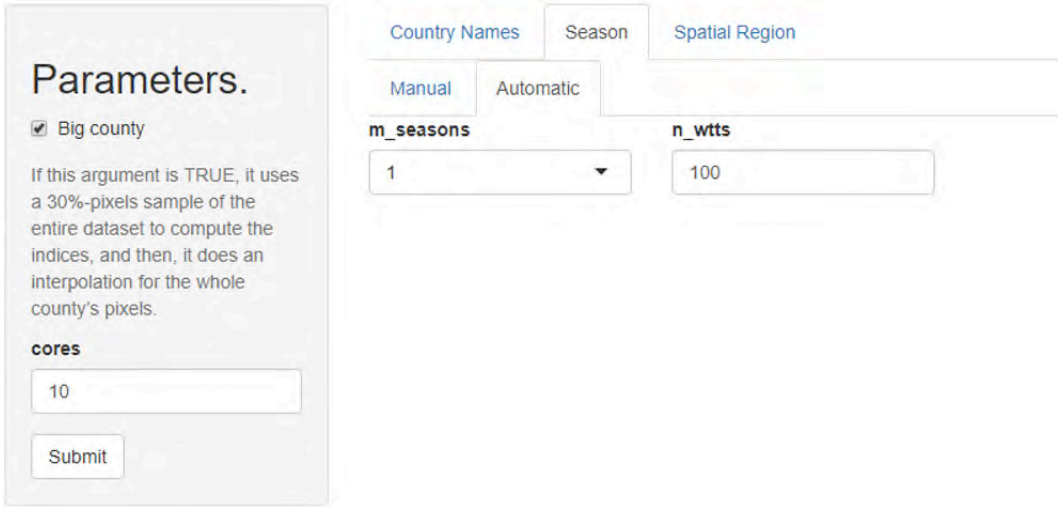
Choosing the manual option makes it possible to define the starting and the final months of the crop calendar (Figure J.9).

Figure J.9. Screenshot demonstrating how to manually define the crop calendar.



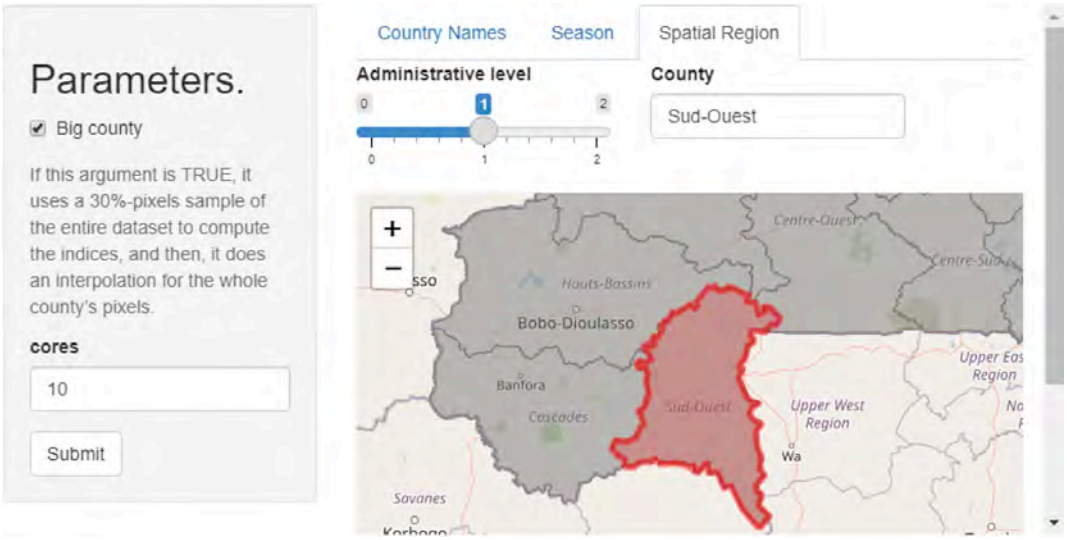
The Automatic option has two associated parameters, which define the number of seasons within a year (m_seasons), and the number of very wet days within a season (n_wtts, defined as the period when the highest amount of rainfall has taken place per site). In the screenshot below, setting m_seasons set to 1 and n_wtts set to 100 defines one season per year with the 100 wettest days (Figure J.10).

Figure J.10. Screenshot demonstrating how to automatically select the crop calendar.



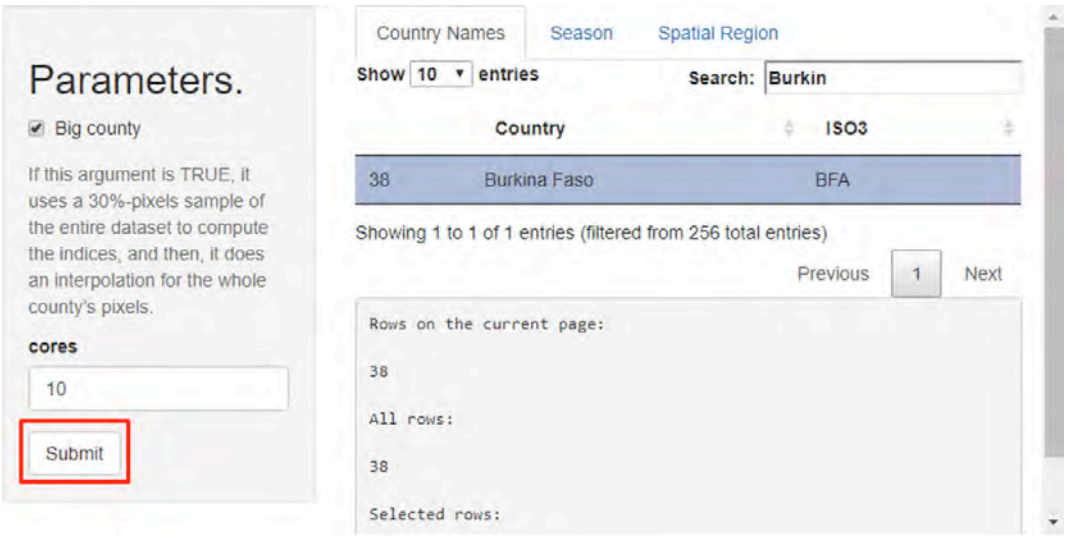
Lastly, if the analysis will be executed by county, the final tab entitled "Spatial Region" defines the region or county of interest (Figure J.11). In the screenshot below, administrative level 1 and the region called "Sud-Ouest" have been selected. The list of regions is based on the administrative units obtained from the GADM database.

Figure J.11. Screenshot demonstrating how to define the study region.



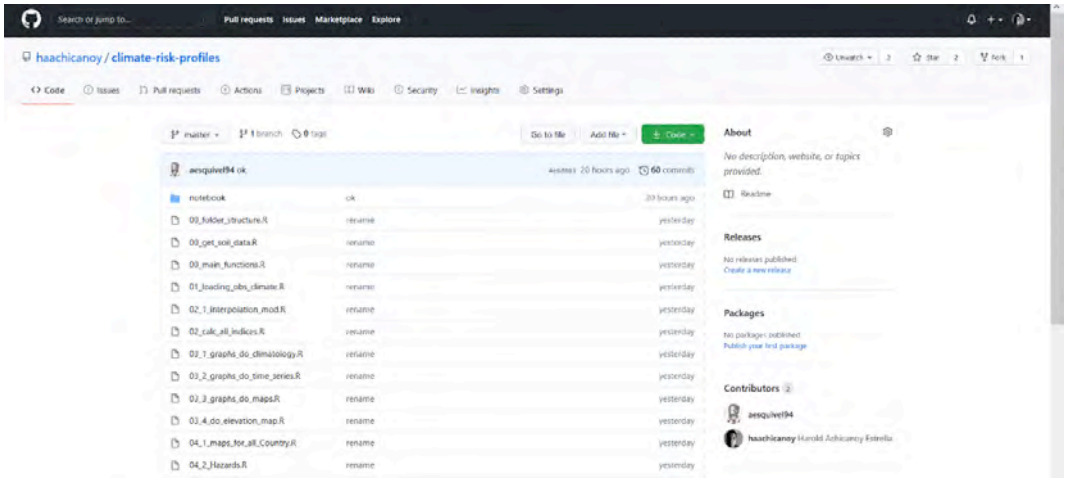
After all the input parameters are defined, it is time to press the "Submit" button in the left panel (Figure J.12).

Figure J.12. Screenshot demonstrating how to submit information.



Step 3 – Processing steps

Figure J.13. Screenshot showing the R scripts for running the method.



Using the input parameters previously obtained from the previous Shiny app, the scripts must be run in the following order (Figure J.13):

1. Define folder structure (00_folder_structure.R): this script defines the folder structure where the processed data, results, and graphs will be stored.
2. Soil data extraction (00_get_soil_data.R): this function uses the ISRIC soil database to obtain the soil water capacity variable for each site because it is an input for the calculation of indices.
3. Climate data structuring (01_loading_obs_climate.R): once the historic climate data is downloaded, this script structures the climate data, which originally was in raster format, into a table with the following columns:
   - ID: location ID
   - Longitude: geographical longitude in decimal units
   - Latitude: geographical latitude in decimal units
   - Country: name of the country under analysis
   - County: name of the county or region under analysis
   - Date: YYYY-MM-DD format
   - tmin: daily minimum temperature data
   - tmax: daily maximum temperature data
   - prec: daily precipitation data
   - srad: daily solar radiation data

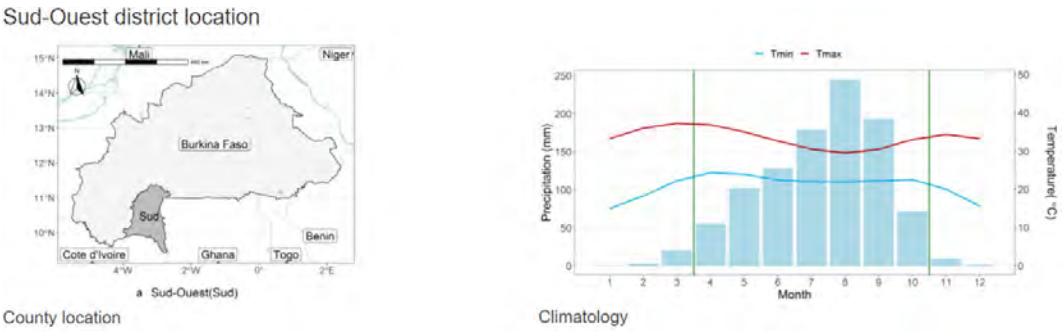
4. Agroclimatic indices calculation (02_calc_all_indices.R): this function integrates climate and soil data to calculate the list of agroclimatic indices across the crop calendar for each year. This script outputs a table with the following columns:
   - ID: location ID
   - Longitude: geographical longitude in decimal units
   - Latitude: geographical latitude in decimal units
   - Country: name of the county or region under analysis
   - County: name of the county or region under analysis
   - Year: year
   - Season: months defined in the crop calendar
   - CDD: maximum number of consecutive dry days
   - P5D: maximum 5-day running average precipitation
   - P95: 95th percentile of daily precipitation
   - NT35: total number of days with maximum temperature greater or equal to 35°C
   - NDWS: number of days with water stress
   - SLGP: starting day of the year for each growing season
   - LGP: length of each of the growing season
   - gSeason: number of growing seasons identified
5. Figures and maps (03_1_graphs_do_climatology.R to 04_2_Hazards.R): With the calculated indices, the next processes create maps and visualizations of location, climatology, and time series data for each index, showing the spatiotemporal variation of the hazards.

Results

The results that will be produced in the interactive HTML notebook are presented in four categories:

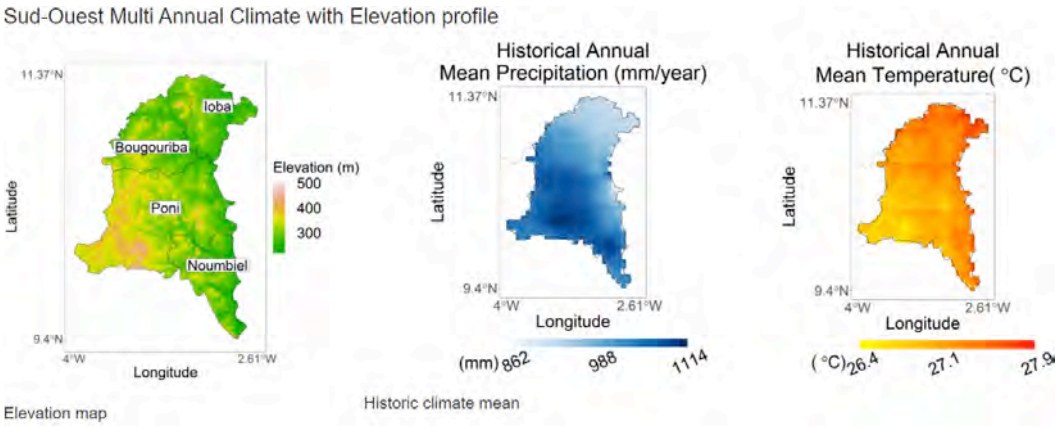
1. **Location map and climatology:** The map corresponds to a location map, to identify the region of interest within the country or continent (Figure J.14). The graph shows the rainfall pattern in the study region using the long-term monthly precipitation average depicted as light blue vertical bars (Figure J.14). In addition, the red and blue lines show the long-term monthly minimum and maximum average temperatures. Finally, the green vertical lines correspond to the select crop calendar.

Figure J.14. Burkina Faso country location and climatology, created in the interactive HTML notebook.



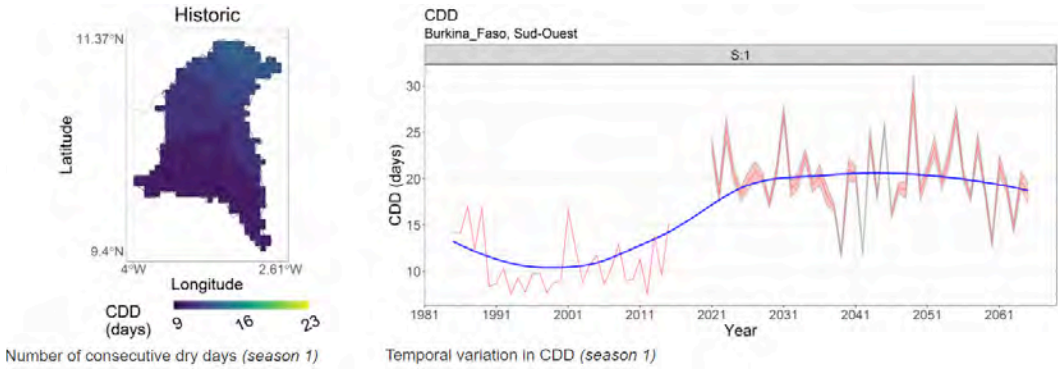
2. **Elevation profile and multi-annual climate:** For each study region, three maps are generated to understand the geography of the area through an elevation profile, as well as the annual precipitation and the annual mean temperature (Figure J.15).

Figure J.15. Burkina Faso county multi-annual climate with elevation profile, created in the interactive HTML notebook.



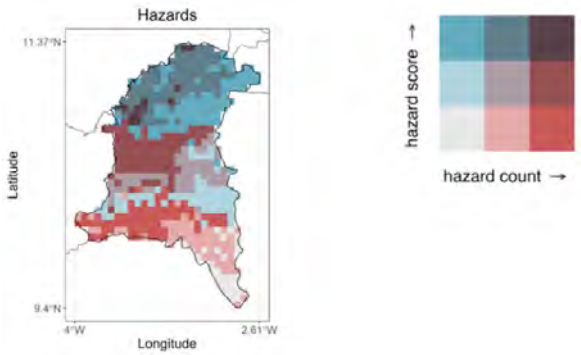
3. **Spatial and temporal trend by index:** For each agroclimatic index, two graphs are presented (Figure J.16). The first one corresponds a map that shows the long-term average of the index over the period 1985-2015. The second graph corresponds to a time series average across all the sites in the study area.

Figure J.16. Example to the Burkina Faso county graphs for one index (map a time series map), created in the interactive HTML notebook.



4. **Hazard combination map:** This map displays the intensity and magnitude of the impact of the weather risks in a categorical way to identify most affected sites (Figure J.17).

Figure J.17. Burkina Faso county hazards example, created in the interactive HTML notebook.

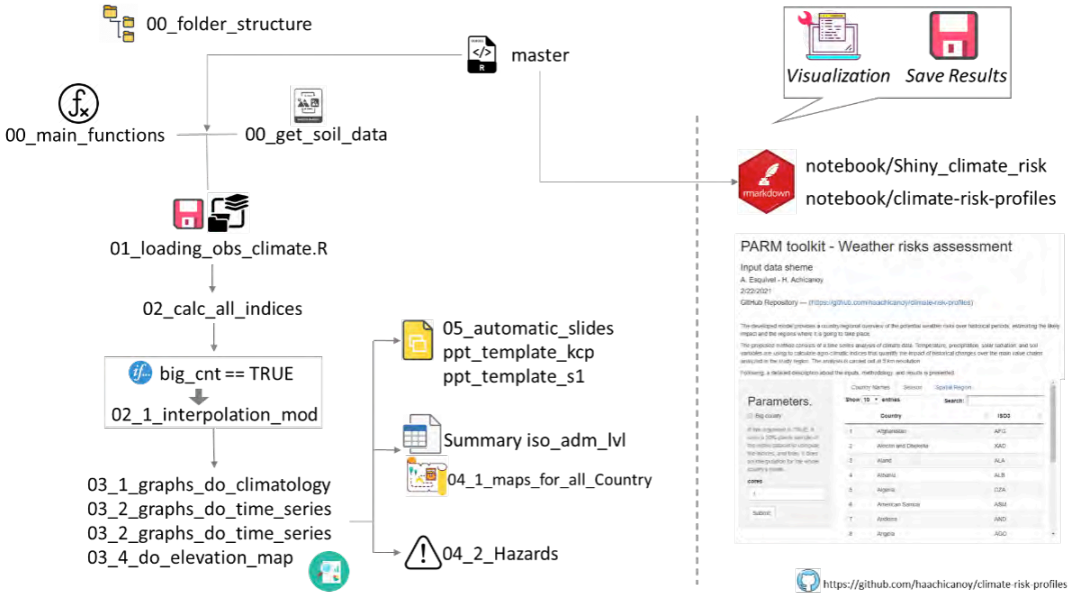


The interpretation of the values for each index should accord with expert knowledge of the region, to relate the quantification of hazards to the production occurring in the specific value chain.

Workflow process

Figure J.18 below presents the relations between the scripts in a graphical way.

Figure J.18. Scripts workflow process.



The interactive notebook is an interface to capture the input parameters provided by the user, and those parameters are the inputs that the rest of the R scripts require to be executed. The master code running in the backend verifies if the R packages are already installed; if not, they are installed automatically.

Folder structure

The PARM_toolkit is the main directory. It contains the Project folder, and the ISO3 folder in our example corresponds to a BFA folder. In our example we used adm_lvl = 1; in this case, the folder's name is therefore adm_lvl_1. The methodology can run several adm_lvl (Scheme 2).

Within adm_lvl_1, there are several further folders. Two of them correspond to input data (Raw_data – Study_Region), one to an intermediate output (processed data), and three are output folders ("Results", "Graphs", "Slides").

Figure J.19. Folder structure.

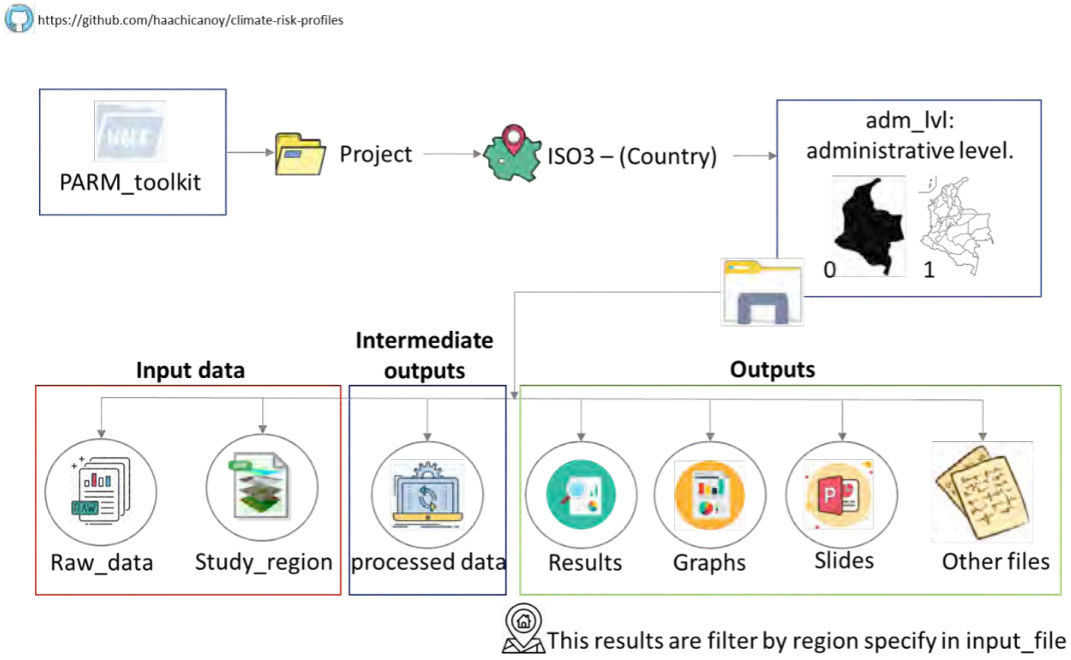
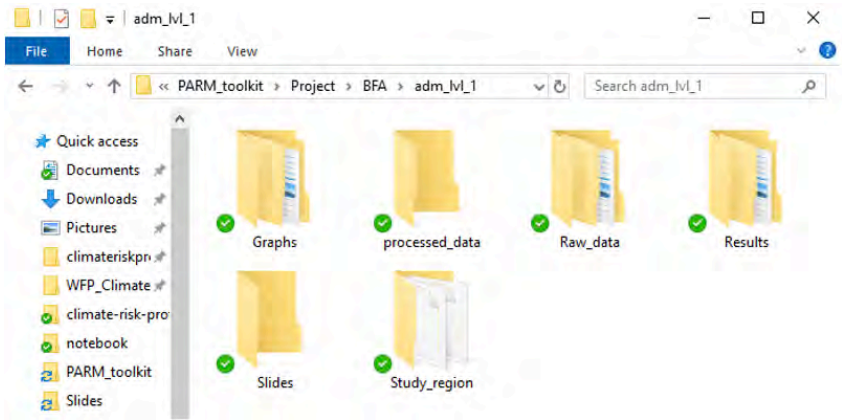


Figure J.20. Example of folder scheme.



- **Raw data:** This folder contains the climate and soil raster data. This information must be provided before running every R script. At this point, the automatic download of this data is not implemented.
- **Study region:** This folder contains the shapefile of the country boundary, and analysis will depend on the definition of an administrative level. This folder downloads automatically from the GADM database using the R scripts.
- **Processed_data:** This folder stores files or intermediate results, such as organized climate and soil tables.
- **Results:** This folder contains raw tables of indices, after calculating the agroclimatic indices.
- **Graphs:** This folder includes one subfolder for each county and stores time series graphs, climatology graphs, and location and elevation maps.
- **Slides:** This folder contains one file of organized results for each county.

Managing risks to improve farmers' livelihoods

Platform for Agricultural Risk Management

International Fund for Agricultural Development (IFAD)

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